

### 3. Initial Evaluation

### **3. INITIAL EVALUATION**

This section presents an initial evaluation of existing information pertinent to conducting a focused RI/FS for the OCVZ Operable Unit beneath and surrounding the SDA. A conceptual model of the contaminant migration at the SDA is presented in Section 3.1. The volatile organic compound (VOC) source descriptions are provided in Section 3.2. The characterization of known and suspected volatile organic contamination is outlined in Section 3.3. Applicable or relevant and appropriate requirements (ARARs) are discussed in Section 3.4. A preliminary assessment of potential effects on health is provided in Section 3.5. Finally, a listing of potential remedial action objectives and remedial alternatives is contained in Section 3.6.

#### **3.1 Pathway/Receptor Model of Volatile Organic Compound Migration at the SDA**

The movement of VOCs is a function of their chemical form and their interaction with the meteorological, hydrogeological, and geochemical characteristics of the SDA. Transport calculations using site specific parameters indicate that VOCs migrate primarily in the gaseous phase. However, they may also be found dissolved in the aqueous phase. Studies have indicated that the vadose zone shows limited zones of perched water (Hubbell 1990); the remainder is not saturated with respect to water. The majority of VOC contaminated samples in the vadose zone have been taken of the gas phase. No organic phase samples have been found.

The SDA is situated above a 580-ft thick vadose zone consisting of fractured basalt and intercalated fine-grained sedimentary interbeds. Moisture movement in the vadose zone will be an important control of aqueous phase contaminant migration from the source through 580 ft of the subsurface to the groundwater. Air permeability of the subsurface will be an important control of vapor phase contaminant migration to the air and groundwater pathways.

The pathway/receptor model of the site (Figure 3-1) depicts the relationship between receptors and the primary source of disposed contaminants. Contaminants are connected to the receptors by the pathways. The pathway/receptor model is divided into a description of the receptors and major pathways, a summary of VOC sources and modes of release, and contaminant movement through the subsurface.

##### **3.1.1 Receptors and Pathways**

The receptors of VOCs from the SDA include humans and terrestrial biota. Two time frames have been identified: an institutional period and a residential period. No additional institutional controls (fences, controlled access, etc.) are assumed for the institutional period access to the RWMC is presently controlled. No institutional controls are assumed for the residential period.

During the institutional period, human receptors are divided into two groups based on the time spent at the site. RWMC workers are at the site 40 h/wk and can experience a variety of scenarios that may include exposure to water from wells at the SDA (drinking and showering), flooding of the area, inhalation of vapors from the surface of the SDA, contact with or ingestion of VOC contaminated soil, and accidental releases of material during routine operations. Visitors spend less than 40 h/wk and usually spend less than 8 h/day at the site. It is assumed that visitors would not be

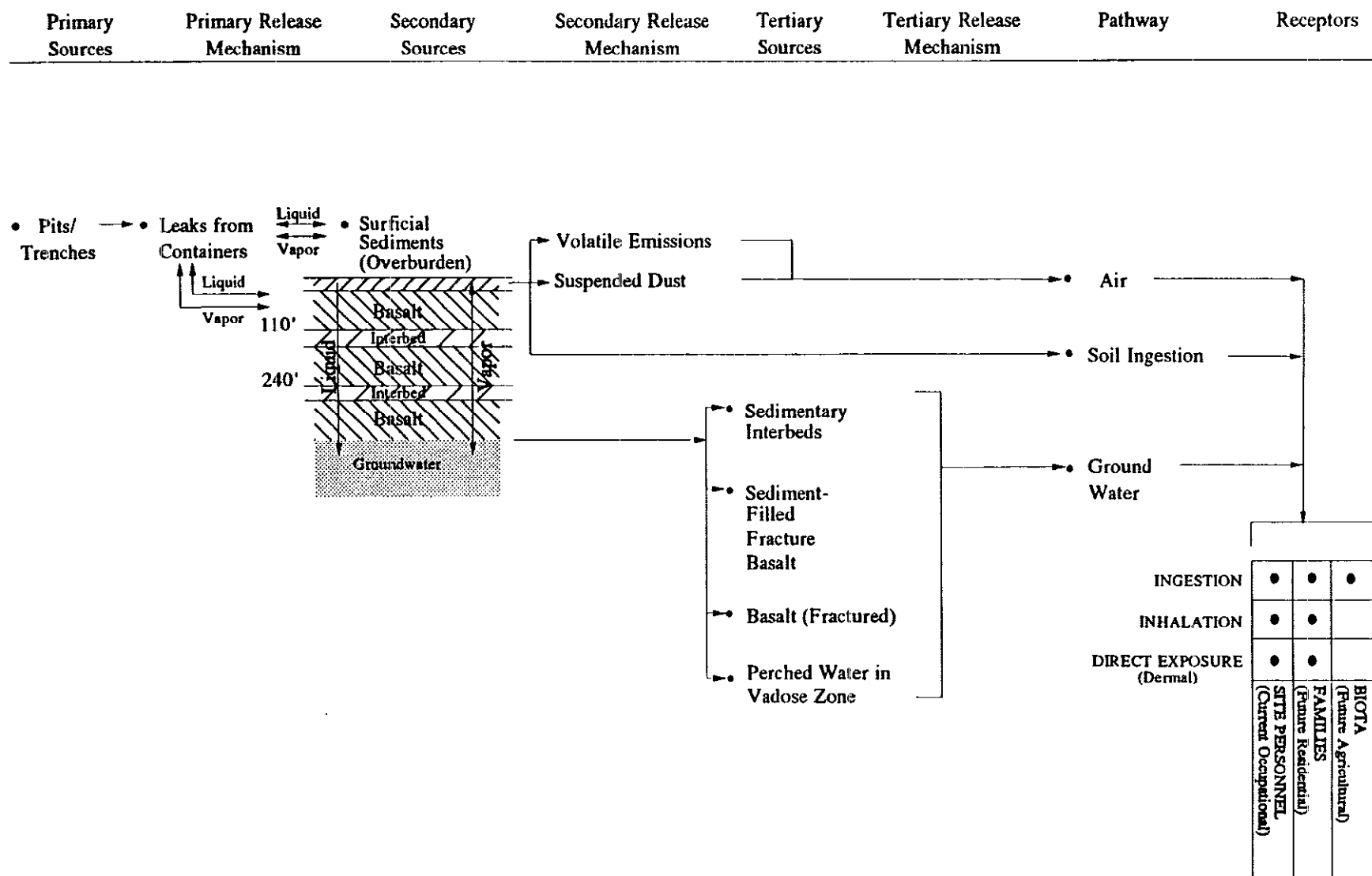


Figure 3-1. RWMC vadose zone preliminary pathway/receptor model.

exposed to scenarios that include aspects of routine operations or unusual occurrences. Visitors would be exposed to water from wells at the SDA through drinking and vapors from the SDA through respiration. Terrestrial biota include desert mammals and birds, migratory waterfowl, reptiles, and amphibians, as well as terrestrial plants and grasses.

During the residential period, human receptors could be living in the SDA. These individuals could be exposed to VOCs through drinking water from the wells at the SDA, contact with or ingestion of VOC contaminated soil, and inhalation of vapors.

The groundwater and air are assumed to be the primary pathways for delivering VOCs to the receptors during both time periods. Groundwater is a pathway for humans through wells which may provide water for direct consumption or contact (drinking, cleaning, recreation, etc.) and indirect consumption or contact (farming, ranching, hunting, fishing, etc.). Air is a pathway to humans and biota through its capability of transporting VOCs to both receptors for direct contact. Direct dermal contact or ingestion of soils is a pathway to humans. The interaction between receptors and the pathways is given as a matrix on the right hand side of Figure 3-1. Modes of exposure to contaminants include ingestion and inhalation.

### **3.1.2 Basis for Risk Scenarios**

The following list provides the basis for evaluating risk scenarios as defined by EPA and IDHW:

1. No additional institutional controls during current institutional period.
2. No institutional controls during residential.
3. Institutional period
4. Residential period

### **3.1.3 Contaminant Sources and Release Mechanisms**

VOCs may be released from stored waste (primary source) to surficial sediments (secondary source) and to vadose zone basalts, interbeds, and perched water (tertiary source). VOCs are released from the primary, secondary, or tertiary sources to various pathways by volatile emission or infiltration/leaching. The following sections provide a description of the soil, basalt, interbeds, and perched water sources and associated contaminant release mechanisms.

**3.1.3.1 Primary Sources of VOCs and Release Mechanisms.** The primary sources of VOCs have been identified at the SDA. The first and largest source includes inactive pits and trenches. TRU and hazardous wastes were disposed in the inactive pits and trenches until 1970, and low-level waste was disposed in pits between 1970 and the present. These TRU, hazardous, and low-level wastes are the source of VOCs.

The pits and trenches are capable of releasing contaminants to the environment through emission of VOCs to the air or through transport caused by infiltration of aqueous phases and by leaching of the waste. The inactive pits and trenches and the active low-level waste pit could release contaminants through a flooding event.

**3.1.3.2 Secondary Sources of VOC Contaminants and Release Mechanisms.** Secondary contaminant sources result from volatile emissions, infiltration and leaching, or flooding of primary sources. Surficial sediments around and beneath the pits and solid cover over inactive pits and trenches are secondary sources that could release contaminants through the following secondary mechanisms:

- Blowing dust particles
- Volatile emissions
- Infiltration and leaching.

The secondary release mechanisms move contaminants directly into the air pathways from the surficial sediments (see Figure 3-1) or to the vadose zone, and hence to the aquifer, via infiltration, leaching, or vapor transport.

**3.1.3.3 Tertiary Sources of Contaminants and Release Mechanisms.** The volatile emissions, infiltration, and leaching of surficial sediments contribute to the formation of a tertiary source of contaminants. VOCs and aqueous solutions derived from infiltration and leaching processes can contaminate the vadose zone. Four tertiary sources are identified by contaminant emission or infiltration/leaching. Those sources are

- Sedimentary interbeds
- Sediment in filling fractures in basalt
- Basalt
- Perched water in the vadose zone.

Contaminants can move through further volatile emissions and infiltration/leaching into the groundwater pathway and air pathway from these tertiary sources.

#### **3.1.4 Volatile Organic Contaminant Migration at the SDA**

Understanding transport of VOCs through the unsaturated zone is complicated by the fact that these contaminants may exist primarily in three phases: (1) aqueous (or dissolved) phase, (2) a nonaqueous phase (i.e., Regal Oil), and (3) a vapor phase. Because of the volatile nature of the organics, there is rapid partitioning between aqueous, nonaqueous, and vapor phases. The generation rate of the vapor phase can be estimated directly from the mole fractions of the liquid phase components, pure component vapor pressures, and soil temperatures.

Site characteristics and waste properties suggest that transport of organic vapors occurs by the following mechanisms: (a) vapor transport, (b) aqueous transport, and (c) nonaqueous transport. The rate of vapor transport increases with an increase in volatility. Aqueous transport is minimized by the dry nature of the site, and nonaqueous transport is minimized by the increased viscosity of the oil relative to the contaminants of concern. The processes and mechanisms affecting vapor transport are

- Molecular diffusion
- Mechanical dispersion
- Advection by air flow
- Gravity (vapors are heavier than air)
- Dissolution and transport in soil-water
- Adsorption in natural organic matter in the soil
- Abiotic and biotic (bacterial) degradation.

These processes are illustrated in Figure 3-2.

In the surficial sediments, transport of organic vapors will be dominated by the processes of molecular diffusion and advective air flow. These processes dominate during low moisture conditions in the soil and account for the venting of the vapors to the atmosphere. During conditions of high soil-moisture, such as during a flooding event, the processes of dissolution and liquid transport are dominant. As a result, it is possible that water flow through the unsaturated zone can play a role in determining the rate and direction of organic vapor transport (Figure 3-3). The porosity system in the basalt layers may be a major factor controlling the direction of vapor transport because the vapor will preferentially follow fractures and porous intraflow structures.

Horizontal movement along interbeds is expected to be emphasized if the soil-water levels are low (i.e., 10% saturation or less). In cases where soil-water levels are near saturation, the sedimentary interbeds may act as retardants (because the pores are filled with water) to the organic vapors.

For VOCs in the aqueous phase, diffusion and advection are expected to be dominant transport process. Movement of organic dissolved in the aqueous phase through the geologic system will follow the patterns of groundwater flow; however, they will be retarded because of attenuation and adsorption. Annual average percolation rates at the RWMC may be on the order of a few cm/y and may not induce much movement of the aqueous phase component. It is possible, however, that the past flooding events have acted to transport some aqueous phase contaminants from the pits to the sedimentary interbeds.

The nonaqueous phase organics are expected to be the least mobile component of the organics because of their higher viscosity. The nonaqueous phase component consists of machine oil. Oil released from failed 55 gal drums is assumed to remain in the immediate vicinity of the containers due to the high viscosity. However, it may move downward within open fissures in the basalt. No organic phase liquids have been found in the subsurface. Any significant movement of the nonaqueous phase could occur by immiscible displacement. Past flooding events may have induced some degree of immiscible displacement of the nonaqueous phase. Low viscosity hydrocarbons, not on the initial waste inventory reports, may also exist.

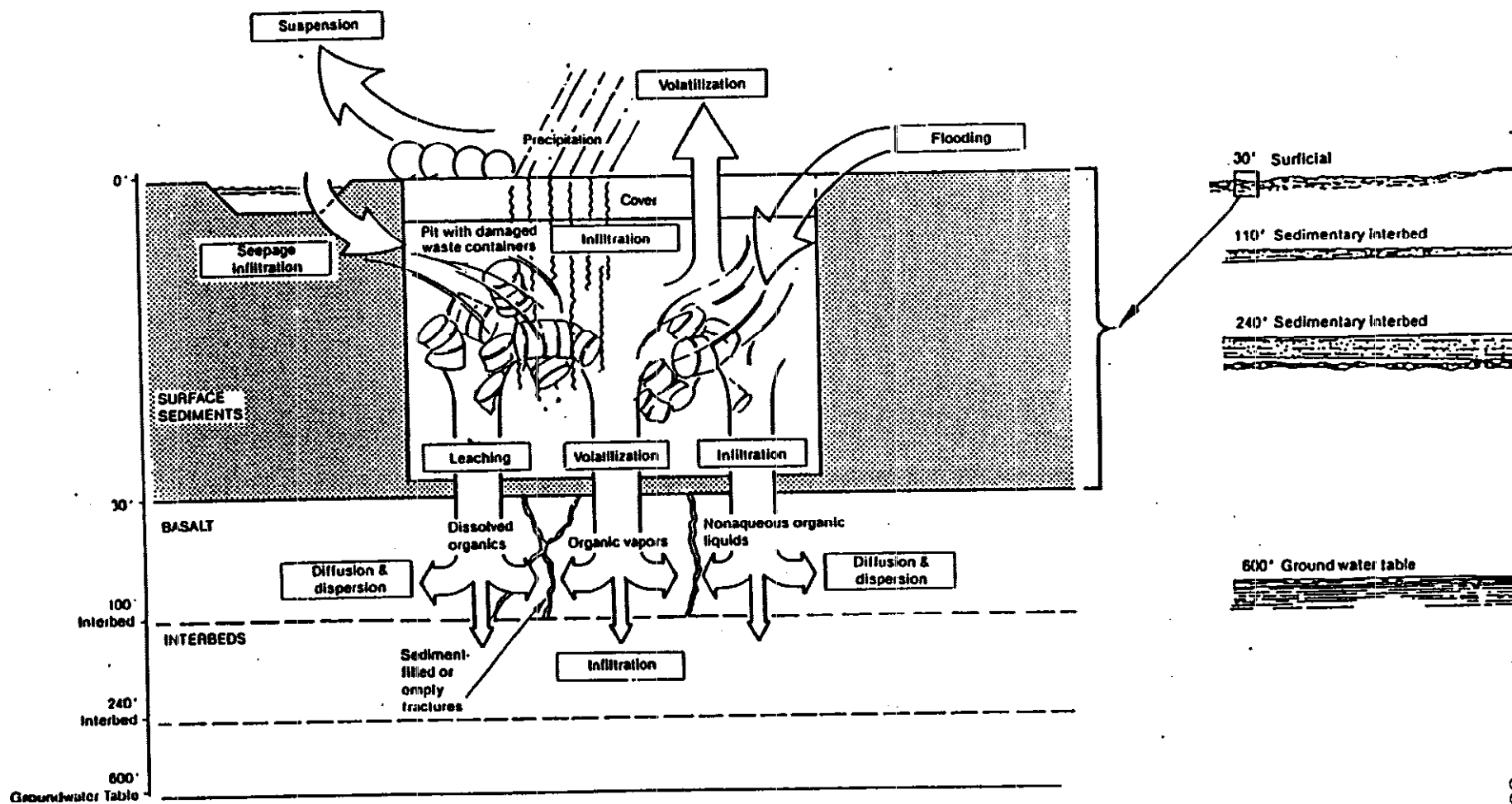
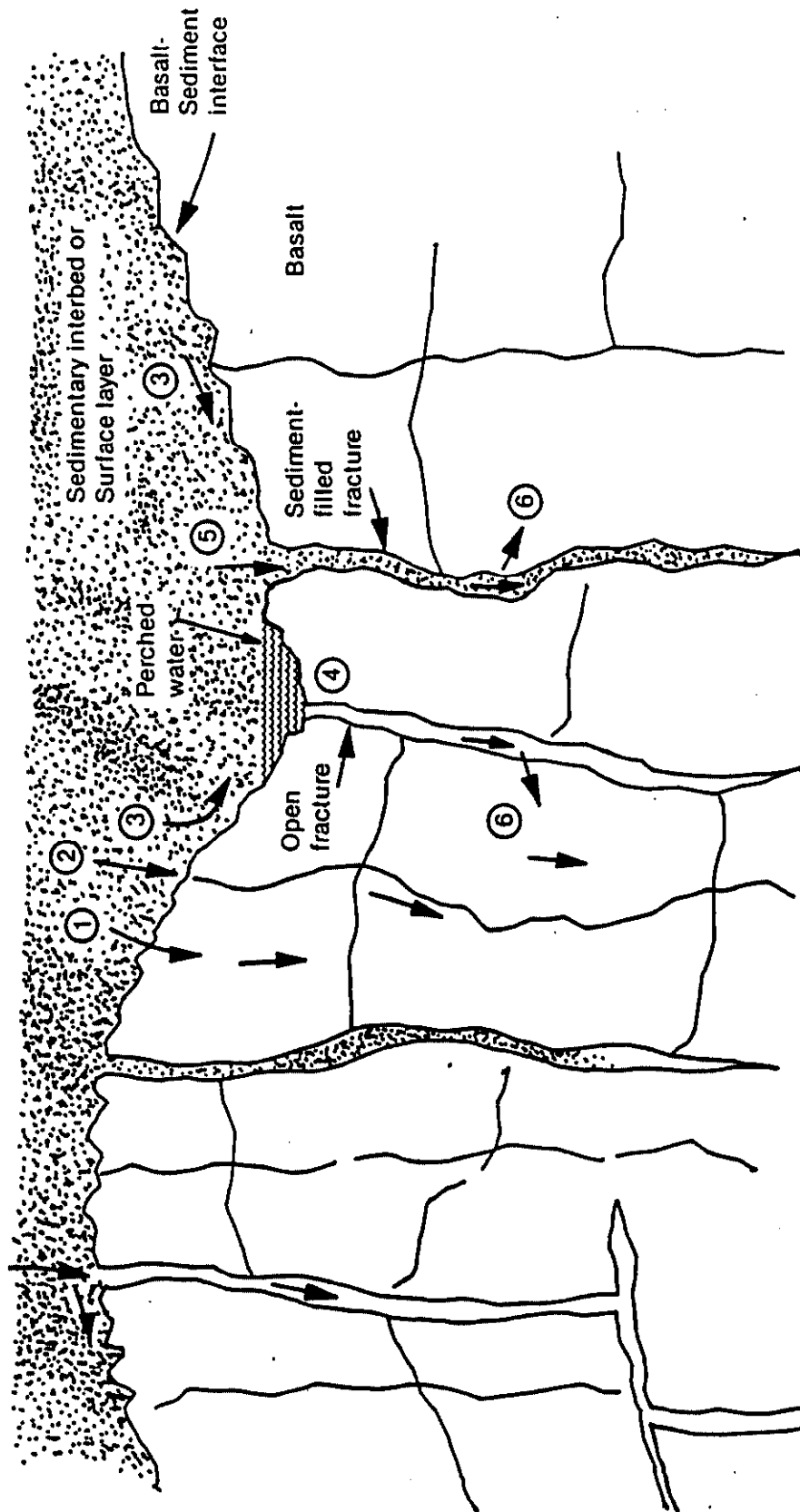


Figure 3-2. Conceptual model of VOC containment migration at the SDA.



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**Figure 3-3.** Conceptual view of water movement across or along a basalt-sediment interface and through the basalt matrix and fractures.



The nature of water movement through the unsaturated sequence of fractured basalts and sedimentary interbeds may be largely controlled by the hydraulic characteristics of the basalt-sediment interfaces as shown in the following numbers in Figure 3-3:

1. Some water may flow from sediments into and through intergranular pore space in the basalt matrix
2. Some flow may occur in basalt in closed fractures and joints with capillary permeability
3. Lateral flow may occur along an interface because of contrast in hydraulic properties
4. Water will not drain out of sediments into an open fracture until sediments become saturated at the interface
5. Some water will flow from a sedimentary layer into sediment-filled cracks
6. Some water will move out of fractures into the basalt matrix.

If future flooding and deep infiltration of water is excluded, migration of aqueous and nonaqueous phases should be very slow. Migration of vapor phase organics is expected to continue as long as waste sources exist in the pits. However, the vapor phase may be amenable to simple remedial measures, such as vapor vacuum extraction.

## **3.2 Contaminant Inventory**

### **3.2.1 Volatile Organic Compounds**

There have been three waste characterization investigations conducted. The first investigation in 1980 was to identify potential nonradiological hazards included in radioactive waste shipments received at the INEL from off-Site generators. In 1981, a second investigation was conducted to identify potential nonradiological hazards included in TRU wastes stored at the TSA. From these two investigations, it became apparent that one aspect of source characterization that had not been fully investigated was organic wastes generated by Rocky Flats Plant, one of the largest off-Site generators. This led to a third investigation in 1987 to estimate the quantity of various Rocky Flats Plant-generated organic wastes at the RWMC.

In performing the waste characterization investigations, the waste management personnel at the Rocky Flats Plant were contacted by telephone, letters, and visitation. The objective of the 1987 visit to Rocky Flats Plant was to obtain as much data as possible on quantities of volatile organic wastes that had been shipped to the SDA. Various Rocky Flats Plant waste management personnel were interviewed, including the retired manager of the Waste Treatment Facility, M. E. Maas, who was present during the 1980 and 1981 investigations.

It was known from the previous investigations that the primary source of organic waste material from the Rocky Flats Plant sent to the INEL was in Rocky Flats Plant Content Code 3 - Organic Setup Sludge (74 Series Sludge). The total volume of used oil, carbon tetrachloride, trichloroethane, trichloroethylene, and perchloroethylene that was received by the Waste Treatment Facility at the Rocky Flats Plant and the dates of receipt were obtained from the Rocky Flats Plant Waste Management monthly reports.

These monthly reports also provided data on the amount of lathe coolant received and the number of Content Code 3 drums that were transported to the SDA. Monthly reports for 1966 and 1969 were not available, so quantities were estimated based on previous information on the number of drums of Content Code 3 waste shipped to the SDA.

The generator interviews and records searches resulted in the following:

- Amounts of hazardous materials generated by off-Site generators stored or disposed of at the RWMC were quantified
- Unique waste characteristics attributable to organic material processes were identified.

### **3.2.2 Additional Compounds**

The buried waste contains toxic chemicals (mercury, thallium oxide, cyanide, benzene, etc.), pyrophoric materials (zirconium chips and sodium), animal carcasses and excreta, and other hazardous materials (acids, gasoline, etc.) that are also radioactively contaminated (see Table 3-1).

Table 3-1 is a compilation of hazardous materials that have been input into the Radioactive Waste Management Information System data base from available shipping documents. It should be noted that this is not a complete list of all the hazardous materials buried in the SDA, but only a general representation of hazardous waste based upon those available shipping documents.

The organic wastes comprised mainly lathe coolant (machining oil and carbon tetrachloride), used oils, and degreasing agents such as trichloroethane, trichloroethylene, and perchloroethylene (Table 3-2). Approximately 88,400 gal of organic waste from the Rocky Flats Plant were disposed at the SDA from 1966 to 1971. The organic waste included 24,000 gallons of carbon tetrachloride and 25,000 gallons of other volatile chlorinated hydrocarbons (Table 3-3).

The most significant volume of hazardous organic material at the SDA is found in waste identified as 74 Series Sludge, which was generated by the Rocky Flats Plant (Engineering Design File RWP-ISV-024). The Rocky Flats Plant, formerly operated by the Rockwell International Energy Systems Group for the DOE, fabricates plutonium and other components for use in the weapons program. Radioactive wastes generated by the Rocky Flats Plant originate primarily from foundry operations, component fabrication, plutonium recovery and purification operations, analytical research and development activities, and waste treatment facilities.

The locations of organic sludge disposal in the SDA can be tentatively identified by using the specific year and annual quantity information obtained from the Rocky Flats Plant, and correlating that information with the pits in the SDA that were open during that same time period. An example would be the year 1969, in which it has been estimated that 533 drums of organic waste were shipped from the Rocky Flats Plant to the SDA (Table 3-3). During the same time period, Pits 6, 9, and 10 were open and can be assumed to have received this waste. Using this methodology, Pits 4, 5, 6, 9, and 10 have been identified as potentially having received the Rocky Flats Plant organic wastes.

**Table 3-1.** Estimates of hazardous materials disposed of at the SDA.<sup>a</sup>

Material	Volume (m <sup>3</sup> )	Volume (ft <sup>3</sup> )	Volume (gal <sup>c</sup> )
Rags <sup>b</sup>	128	4,500	NA
Oil (in absorbent)	89	3,100	23,400
Lead	170	6,100	NA
Asbestos/lagging	100	3,500	NA
Ethylene glycol	1.5	50	390
Mercury	8.5	300	2,240
Acids (HF, HCl, etc., in absorbent)	38	1,400	10,200
Organics (ether, etc.)	25	900	6,700
Santo Wax <sup>c</sup>	200	7,100	53,700
Sodium, sodium compounds, and pipe	105	3,700	27,600
Batteries	0.5	20	NA
Benzene	0.1	3	20
Animal carcasses and feces	71	2,500	NA
Vehicles <sup>d</sup>	24	860	NA
Cyanide	<0.01	<0.35	NA
Meat w/botulinus	0.05	0.25	NA
Tritium vials	2	64	NA
Zirconium chips	30	1,100	NA
Caustic compounds (NaOH in absorbent, etc.)	26	930	6,900
Paint chips and cans	6	210	1,600
Gasoline (absorbed)	5	180	1,300
Ammonia bottles	0.2	7	NA
Thallium oxide	<0.1	<3	NA

**Table 3-1.** (continued).

Material	Volume (m <sup>3</sup> )	Volume (ft <sup>3</sup> )	Volume (gal <sup>e</sup> )
TRU Texaco Regal Oil	148	5,215	39,018
TRU carbon tetrachloride	92	3,263	24,413
TRU other organics	<u>94</u>	<u>3,338</u>	<u>24,968</u>
TOTAL (approximate)	1,364	48,344	222,450 <sup>d</sup>

a. Source: Laney et al. (1988).

b. The quantity identified assumes 5% of the total rag inventory at the RWMC is oil/solvent soaked.

c. Santo Wax is from the Organic Moderated Reactor Experiment; it may not be a hazardous material.

d. Vehicles disposed of at the RWMC were assumed to be driven into the pits with fuel, oil, antifreeze, and batteries left in place. The volume indicated represents 5% of the total vehicle volume.

e. Gallons are not volume equivalent due to some solid materials. NA volume, in gallons, is an inappropriate measure for these materials.

**Table 3-2.** Organic liquids from Rocky Flats Plant processed at SDA monthly.

Organic liquid	Gal/mo	Percent of total
Lathe coolant (60% Texaco Regal Oil, 40% carbon tetrachloride)	700	47
Trichloroethane	150	10
Miscellaneous (hydraulic oil, gearbox oil, spindle oil, 1,1,2-trichloro-1,2,2-trifluoroethane, Varsol, etc.)	650	43
Reference: EDF-BWP-ISV-024		

**Table 3-3.** Organics shipped from Rocky Flats Plant to the SDA.

Year	SDA status	Number of drums	(Volumes in gallons)		
			Texaco Regal oil	Carbon tetrachloride	Other organics <sup>a</sup>
1966	Buried	267	2,000 <sup>b</sup>	800 <sup>b</sup>	No record
1967	Buried	5,518	22,247	14,832	4,255
1968	Buried	2,391	10,771	7,181	18,313
1969	Buried	<u>533</u>	<u>4,000<sup>b</sup></u>	<u>1,600<sup>b</sup></u>	<u>2,400<sup>b</sup></u>
	TOTAL	8,709	39,018	24,413	24,968

a. Mostly 1,1,1-trichloroethane, trichloroethylene, perchloroethylene, and used oil.

b. Data estimated.

Reference: EDF-BWP-ISV-024

This information strongly correlates with the results of the soil-gas survey. The highest concentrations of soil gas are for the most part associated with Pits 4, 5, 6, 9, and 10 at the SDA. The trenches in the southeastern portion of the SDA received INEL-generated wastes. Investigations are being conducted to determine the source(s) and characteristic(s) of the wastes deposited in that portion of the SDA.

Although the dates of the waste shipment to the SDA may be correlated with the dates specific pits were open, the quantity of organic waste placed in each individual pit can only be estimated. Existing records are inadequate to determine specific waste placement. One estimation method would be to use the existing Radioactive Waste Management Information System, which contains data on the amount of 74 Series Sludge placed in individual pits. The Radioactive Waste Management Information System data do not differentiate between the four types of Rocky Flats Plant sludges; that is, Rocky Flats Plant Content Codes 1 to 4 are all categorized into a single INEL Content Code 2-74 Series Sludge in the Radioactive Waste Management Information System. However, Radioactive Waste Management Information System data can be used to get a percentage of the total amount of sludge received and subsequently placed in each pit. Assuming that the distribution of the sludge received was independent of the specific nature of the different sludge types, an estimate of the amount of organic sludge placed in each pit can be made using annual organic sludge quantities and the percent distribution of the sludge among the pits.

### 3.2.3 Volatiles Organics

Table 3-4 shows an estimate of volatile organics buried in the SDA. TRU-contaminated Regal Oil, carbon tetrachloride, and other organics, which were generated at the Rocky Flats Plant, are constituents of the 74 Series Sludge. The 74 Series Sludge consists of different types of sludge depending on the process used at Rocky Flats. Pits 4, 5, 6, 9, and 10 received 74 Series Sludge. Table 3-5 shows the volume of 74 Series Sludge disposed of at various pits. It is assumed that the other organics shown in Table 3-4 are distributed evenly in all the pits.

The investigation identified five types of 74 Series Sludge sent to the INEL from the Rocky Flats Plant. Starting in the 1970s, the four sludges were differentiated in computer data bases and logbooks at the Rocky Flats Plant by content codes. Rocky Flats Plant Content Code 1 designated a wet sludge produced from treating aqueous process wastes. Rocky Flats Plant Content Code 2 was a wet sludge produced from the treatment of all other plant radioactive and/or chemical contaminated wastes and further treatment of Content Code 1 waste. Content Code 2 sludge contained very little organic material but may have occasionally contained bottles of chemical wastes (usually liquid). Rocky Flats Plant Content Code 3 sludge was the organic setup waste produced from treatment of liquid organic wastes generated by various plutonium and nonplutonium operations. Rocky Flats Plant Content Code 4 sludge consisted of liquids absorbed and solidified with a cement mixture to prevent desorption. The most significant contributor to the volatile organic material at the SDA appears to be the Rocky Flats Plant Content Code 3, 74 Series Sludge. Data from the Radioactive Waste Management Information System do not distinguish between the four different types of Rocky Flats Plant 74 Series Sludge sent to the SDA; all are designated as Content Code 2. Thus, the differences between the organic sludge (Content Code 3) and the nonorganic sludges from the Rocky Flats Plant cannot be determined using Radioactive Waste Management Information System data.

Other inadequacies arise when using data from the Radioactive Waste Management Information System data base. As shipments arrived at the RWMC, personnel responsible for logging those shipments classified an entire load of waste under one classification even though different wastes were received in one shipment. There is also a significant amount of redundancy in the content code designations for similar type wastes. An investigation to estimate the quantity of various Rocky Flats Plant-generated organic waste was performed in 1987. From this investigation, it was determined approximately how much Rocky Flats Plant Content Code 3 sludge was sent to the SDA. Table 3-3 shows the amount of organics shipped from the Rocky Flats Plant to the SDA by year.

Descriptions of the five types of sludges shipped to the INEL from the Rocky Flats Plant Aqueous Waste Treatment Facility were not identified separately on shipping documents. All the waste shipped from this facility was categorized by the accompanying shipping documents as 74 Series Sludge. Since the Radioactive Waste Management Information System data base used the shipping documents as initial data, the current data base does not specify the amount of the four specific sludge types shipped to the SDA. However, a breakdown of the individual sludge type generated by the Rocky Flats Plant on an annual basis has been obtained from the plant. The breakdown is listed in Table 3-5. From this table as well as further investigations that took place in 1987, the amount of organics shipped annually and processed by the SDA monthly has been estimated.

Before shipment from the Rocky Flats Plant, the liquid organic wastes were mixed with calcium silicate to form a grease or paste-like material. Normally, small amounts of absorbent, such as Oil-Dri, were also mixed with the waste to bind free liquids. However, that treatment did not result

**Table 3-4.** Estimated organics buried in the SDA.

Material	Volume (m <sup>3</sup> )	Volume (gal)
Oil (in absorbent)	89.0	23,400
Ethylene glycol	1.5	390
Organics (ether, etc.)	25.0	6,700
Santo Wax <sup>a</sup>	200.0	53,700
Benzene	0.1	20
Gasoline (absorbed)	5.0	1,300
TRU Texaco Regal Oil	148.03	9,018
TRU carbon tetrachloride	92.0	24,413
TRU other organics <sup>b</sup>	<u>94.0</u>	<u>24,968</u>
<b>TOTAL:</b>	<b>654.6</b>	<b>173,909</b>

a. May not be a hazardous material.

b. 20% 1,1,1-trichloroethane, 80% consists of trichloroethylene, perchloroethylene, and used oil.

Reference: EDF-BWP-ISV-024

**Table 3-5.** Disposal of 74 series sludge.

Years	Sludge type	Volume (gal)
1953-1966	741	3,448,786
	742	5,980,554
1953-1969	743	478,995
1967-1969	741	1,726,552
	742	2,333,107
	744	790,907
	745	3,287,904

Reference: EDF-BWP-ISV-024

Note: Pits 4, 6, 9, and 10 received 74 Series Sludge during the 1967-1969 period. Pits 4, 5, 6, 9, and 10 received 74 Series Sludge during the 1953-1969 period. Sludges 741, 742, and 745 are inorganic in nature. Sludges 743 and 744 contain organic constituents.

in permanent fixation or immobilization of the organic components. Table 3-2 presents data provided by the Rocky Flats Plant concerning the major organic liquids and quantities from the Rocky Flats Plant processed at the SDA each month.

Since Pit 9 has been the most highly characterized pit, a specific estimate of hazardous organics in Pit 9 is shown in Table 3-6. Although other pits have also received similar wastes as Pit 9, it is not the intent to portray Pit 9 as typical of other SDA pits, but rather as a general example.

### **3.3 Characterization of Known and Suspected Volatile Organic Contamination**

#### **3.3.1 Meteorological and Air Quality Investigations**

The INEL air quality and meteorological monitoring programs are designed to collect data on the entire Site and are not specific to RWMC. Meteorological data have been collected at over 40 locations around the INEL. Telemetered wind measurements were collected at all stations (Bowman et al. 1984). One station is located at the RWMC and collects data on wind speed and direction, temperature, and precipitation (Bowman et al. 1984). These data are available through Environmental Monitoring and are suitable for atmospheric dispersion modeling and estimation of ambient contaminant concentrations.

The meteorological data for 1950 through 1983 have been summarized (Bowman et al. 1984). The summary contains data on surface temperatures, vertical temperature profiles, heating degree days, precipitation, atmospheric pressure, relative humidity, surface winds, upper level wind speeds, solar and terrestrial radiation, and documentation of extreme weather phenomena such as thunderstorms.

VOCs are not routinely monitored at the RWMC. The only nonradioactive airborne contaminant routinely monitored at the RWMC is total suspended particulate. Concentrations of total suspended particulate at the RWMC were significantly greater than Site, boundary, or distant station mean concentrations for 1988 (Bowman et al. 1984). Hence, if organic contaminants are found to be associated with surface soils, suspended airborne organic contaminants may be a significant pathway.

**3.3.1.1 Volatile Organic Compounds.** Grab samples of air in the breathing zone (3 to 5 ft aboveground) and at the surface were collected at SDA for analysis of VOC concentrations. The sampling was performed during drilling operations in 1988 (EG&G Idaho 1988). The samples represented an isolated incident and cannot be used to establish long-term average concentrations.

The specific meteorological conditions present during the sampling will directly affect the observed concentrations. Since no detailed description of the meteorological conditions or sampling techniques is presented, it should not be used as a measure of air quality at the RWMC.

An analysis of soil-gas data and soil concentrations of VOCs is presented in Section 3.3.3. Soil concentrations and soil-gas data (worst-case measurements) were used to estimate volatile emissions from the soil. The calculated emission rates were then used as input to an atmospheric dispersion model for estimation of ambient VOC concentrations on and around the RWMC. The flux was calculated demonstrating that a surface flux measurement was not needed.



**Table 3-6.** Summary of hazardous organics in Pit 9.

Component	Volume (gal)	Volume (m <sup>3</sup> )
Texaco Regal Oil	5,875	22.24
Carbon tetrachloride	3,677	13.92
Used oil (50%)	2,378	9.00
Alcohols	1,287	4.87
Organic acids	1,287	4.87
Versene (EDTA)	1,287	4.87
Ether	838	3.17
1,1,1-Trichloroethane	753	2.85
Trichloroethylene	565	2.14
Perchloroethylene	565	2.14
Gasoline	163	0.62
Ethylene glycol	49	0.19
PCB	—	<u>0.10</u>
<b>TOTAL</b>	<b>18,724</b>	<b>70.87</b>

Reference: EDF-BWP-ISV-024

**3.3.1.2 Summary.** The air quality and meteorological monitoring programs at the INEL have routinely monitored for meteorological parameters, total suspended particulates, and ambient concentrations of radionuclides or particulates. These monitoring programs, however, do not collect data on organic compounds in the air. Grab air samples for VOC analysis have been taken above the ground during drilling operations. VOC concentrations have been modeled using worst-case meteorological conditions. Although both the grab air samples and the dispersion model indicate that the emissions of VOCs from SDA do not present an air quality problem, the data are not sufficient to evaluate the long-term risks to human health either on-Site or outside the INEL. A complete human health risk assessment will require detailed information on the emissions, dispersion, and ambient concentrations of VOCs originating at the RWMC.

### 3.3.2 Groundwater Investigations for Volatile Organic Contamination

Information on the levels of volatile organic contamination at the SDA is available from several groundwater studies. These studies include

- *Organic Solutes in Groundwater at the INEL* (Leenheer and Bagby 1982)
- *Purgeable Organic Compounds in the Groundwater at the INEL, 1987* (Mann and Knobel 1987) and a supplement to this report<sup>c</sup>

c. Mann, L. J., "Water Quality—Purgeable Organic Compounds," letter memorandum, August 8, 1989.

- *Purgeable Organic Compounds in the Groundwater at the INEL, 1988 and 1989* (Mann 1990)
- *Groundwater Characterization Plan for the Subsurface Disposal Area, INEL* (Wood and Wylie 1991).

Leenheer and Bagby (1982), of the USGS Water Resources Division, conducted a reconnaissance survey of pesticides and organic solutes in the Snake River Plain Aquifer in August 1980. Altogether, 77 wells were sampled for analysis of dissolved organic carbon (Figures 3-4 and 3-5). Pesticides were analyzed in samples from four wells. A total of 14 wells were sampled for analyses of volatile and semivolatile organics. Table 3-7 summarizes previous groundwater investigations for VOCs.

The criterion used to identify significant organic solute contamination of the groundwater was a dissolved organic carbon value more than twice the average background value. This criterion may or may not accurately reflect groundwater contamination. Separate background values were used for pump-sampled and thief- or bailer-sampled groundwater, because samples collected by pumping allow purging of the well before collecting the sample and a potential loss of volatiles during pumping. For thief- or bailer-sampled wells, the background dissolved organic carbon was 9.3  $\mu\text{g/L}$ ; for pumped wells, the background dissolved organic carbon was 7.1  $\mu\text{g/L}$  (Leenheer and Bagby 1982). These average background values were established by taking the arithmetic mean of the detected concentrations from 10 wells located away from any known organic contamination. The 10 wells used are shown on Figure 3-4 and include the Atomic City Well, Fire Station #2, Highway #3, P+W-2, Blaine Larsen Well, Site 14, and USGS Observation Wells 4, 19, 26, and 27.

Dissolved organic carbon levels of thief- or bailer-sampled groundwater did not exceed 18  $\mu\text{g/L}$  and pumped samples did not exceed 11  $\mu\text{g/L}$ . Of the 77 wells tested, only 6 (Site 14, Blaine Larsen well, 26, 53, 54, and 58) exceeded 10  $\mu\text{g/L}$  dissolved organic carbon (DOC) (Leenheer and Bagby 1982). None of those wells exceeding 10  $\mu\text{g/L}$  DOC are within 6 miles of the RWMC. Figures 3-4 and 3-5 show the distribution of dissolved organic carbon in groundwater within the INEL during August 1980.

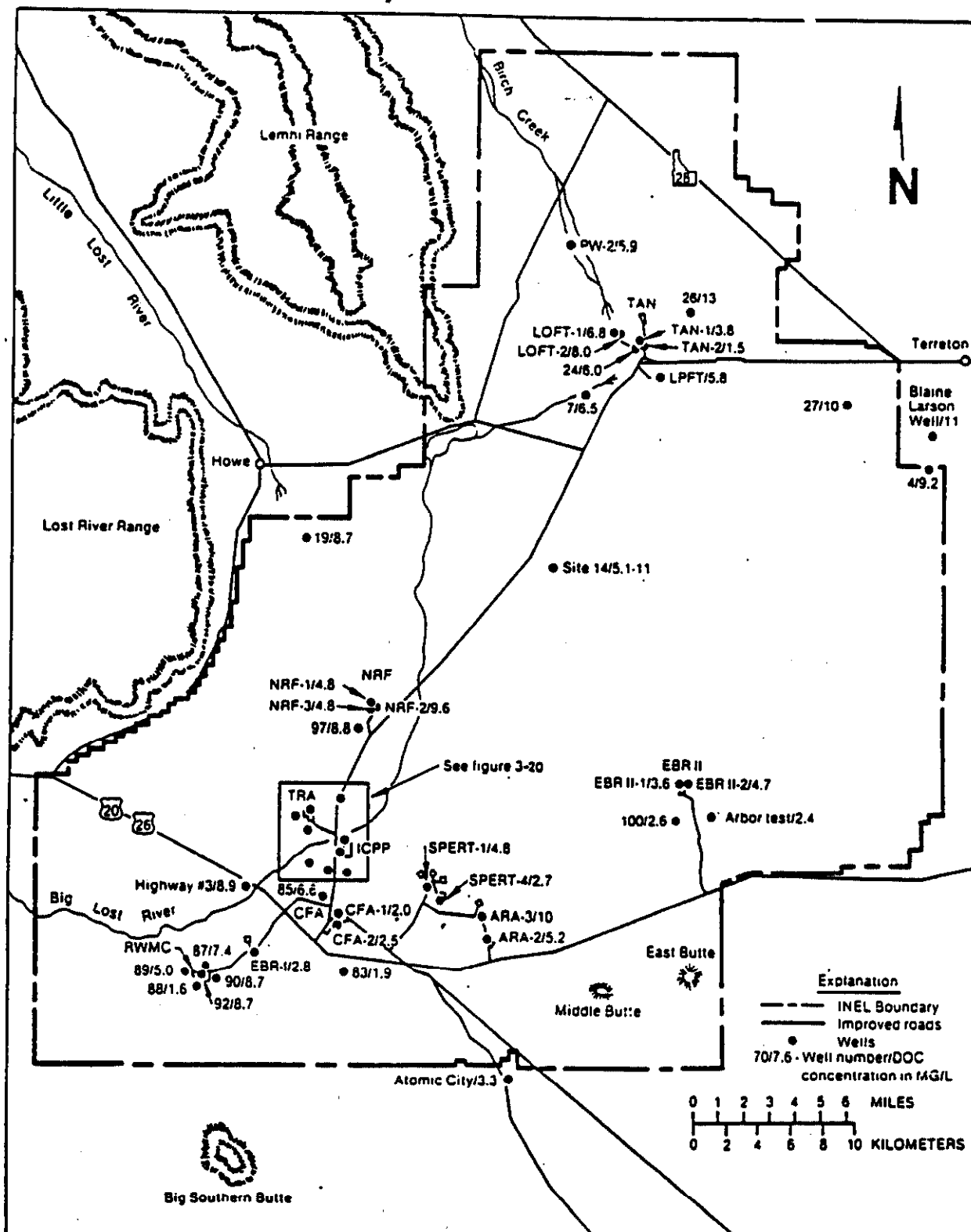
No insecticides or herbicides were detected in any groundwater samples except Observation Well 40 (near the Idaho Chemical Processing Plant), where dichlorodiphenyltrichloroethane (DDT) was detected at 0.01  $\mu\text{g/L}$ .

This low-level (coupled with the absence of detectable insecticides and herbicides in other samples) does not suggest significant pesticide contamination in the groundwater at INEL (Leenheer and Bagby 1982). It should be noted that these results are based on a limited sampling program.

A reconnaissance level study of purgeable organic compounds in the Snake River Plain Aquifer at the INEL was conducted from June to November 1987 (Mann and Knobel 1987) and was supplemented in 1989.<sup>d</sup> Water samples were collected from 81 wells that were equipped with dedicated submersible pumps and analyzed for 36 purgeable organic compounds (listed in Table 3-8). According to EPA protocols, submersible pumps should not be used when sampling for purgeable

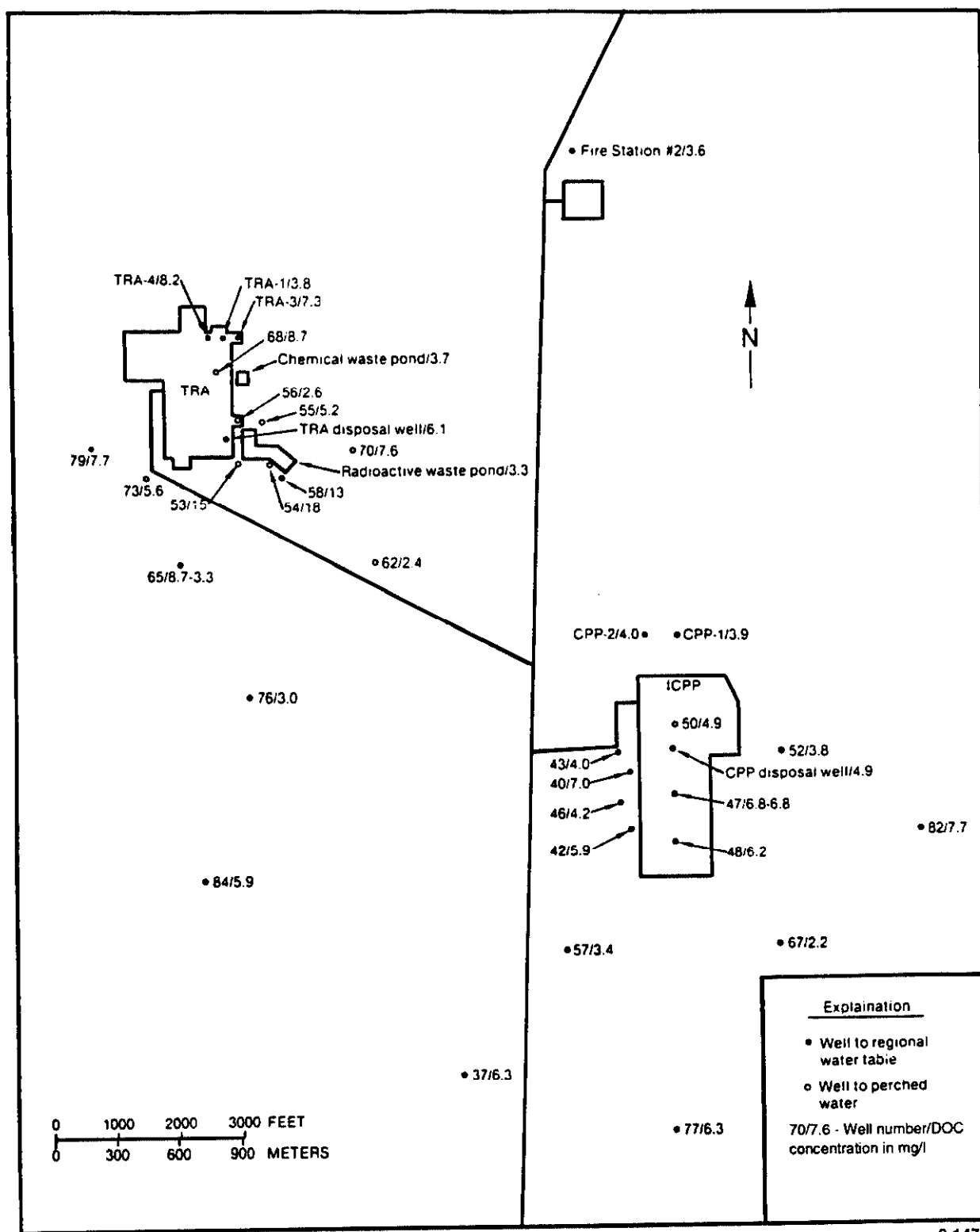
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d. Mann, L. J., "Water Quality—Purgeable Organic Compounds," letter memorandum, August 8, 1989.



9-1522

**Figure 3-4.** Distribution of dissolved organic carbon in groundwater in the INEL vicinity, August 1980 (Leenheer and Bagby 1982).



**Figure 3-5.** Distribution of dissolved organic carbon in groundwater in the ICPP-TRA vicinity, August 1980 (Leenheer and Bagby 1982).

**Table 3-7. Summary of previous groundwater investigations.**

Investigation/reference	Objectives	Field activities	Results	Interpretations/conclusions
<i>Contaminant Transport in the Snake River Plain Aquifer: Phase I, Part I: Simple Analytical</i> (Rood et al. 1989)	To create a preliminary, screening level, semiquantitative assessment of selected contaminants in the Snake River Aquifer.	None, this report is compilation of existing data.	Model-predicted plumes of carbon tetrachloride, iodine-129, tritium, and strontium-90 are presented.	Radionuclides in the aquifer resulting from past discharges do not currently pose a health threat to water users south of the INEL boundary. With planned remedial action to reduce the flux of carbon tetrachloride to the aquifer. It also would likely not exceed EPA maximum concentration levels south of the INEL boundary.
<i>Preliminary Assessment of the Hydrogeology at the Radioactive Waste Management Complex, Idaho National Engineering Laboratory</i> (Wood 1989)	To summarize and evaluate data associated with the Snake River Plain Aquifer in the vicinity of the RWMC in order to help estimate the level of effort needed to characterize the aquifer in this vicinity.	None, this report is compilation of existing data.	With regard to the RWMC, the geology, current groundwater monitoring network, hydrology, aquifer tests, existing data, and proposed future activities for site characterization are discussed.	More groundwater monitoring wells are required to fill data gaps and supplement the wells currently being monitored by the USGS to complete a Site characterization of the RWMC.
<i>Purgeable Organic Compounds in Groundwater at the Idaho National Engineering Laboratory, Idaho</i> (Mann and Knobel 1987)	Complete a reconnaissance-level sampling program for purgeable organic compounds in the groundwater at the INEL.	Water samples from 81 wells that penetrate the Snake River Plain Aquifer and are equipped with dedicated pumps were collected and analyzed for 36 purgeable organic compounds.	Twelve compounds were detected in the samples, including carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, and toluene. The maximum concentration of purgeable organic compounds near the SDA was 6.6 µg/l. of carbon tetrachloride.	The 6.6 µg/L of carbon tetrachloride detected in the groundwater near the SDA is above the EPA Primary Drinking Water Standard (maximum concentration level) of 5 µg/L.
<i>Water Quality Data for Selected Wells on or near the Idaho National Engineering Laboratory 1949 through 1982</i> (Bagby et al. 1985)	To provide written documentation of the water quality data that has been collected by the USGS on or near the INEL during the years 1949 through 1982. It is also to serve as a water quality data reference book.	None. This report is a compilation of existing data.	20,000 individual water quality records for selected wells on or near the INEL were compiled. The data are only from wells that penetrate the Snake River Plain Aquifer.	None. This report is basically a table of data.
<i>Organic Solutes in Groundwater at the Idaho National Engineering Laboratory</i> (Leenheer and Bagby 1982)	Complete a reconnaissance-level survey of organic solutes in drinking water sources, groundwater monitoring wells, perched water-table monitoring wells, and in select waste streams at the INEL.	77 wells and four potential point sources were sampled for dissolved organic carbon. Four wells and several point sources of insecticides and herbicides were sampled for insecticides and herbicides. Fourteen wells and four potential organic sources were sampled for volatile and semivolatile organic compounds.	No dissolved organic carbon contamination greater than 20 mg/L was found. The only detectable insecticide or herbicide was a DDT concentration of 0.01 µg/L in one well. The volatile and semivolatile analyses did not indicate the presence of organic contaminants in amounts greater than 10 µg/L.	According to the authors, there are no "significant" areas of organic contamination of groundwater.

**Table 3-8.** Purgeable organic compounds for which groundwater analyses were performed on samples collected from June to November 1987.<sup>a</sup>

Benzene	Cis-1,3-Dichloropropene
Bromoform	Trans-1,3-Dichloropropene
Carbon tetrachloride <sup>b</sup>	1,3-Dichloropropene
Chlorobenzene	Ethylbenzene
Chloroethane	Methyl bromide
2-Chloroethyl vinyl ether	Styrene
Chloroform <sup>b</sup>	Methylene chloride
Chloromethane	1,1,2,2-Tetrachloroethane
Dibromochloromethane	Tetrachloroethylene <sup>b</sup>
Dichlorobromomethane	Toluene <sup>b</sup>
1,2-Dichlorobenzene	Trichlorofluoromethane
1,3-Dichlorobenzene	1,1,1-Trichloroethane <sup>b</sup>
1,4-Dichlorobenzene	1,1,2-Trichloroethane
Dichlorodifluoromethane <sup>b</sup>	Trichloroethylene <sup>b</sup>
1,2-Dibromoethylene	Vinyl chloride
1,1-Dichloroethane <sup>b</sup>	Xylenes, mixed
1,2-Dichloroethane	
1,1-Dichloroethylene <sup>b</sup>	
1,2-trans-Dichloroethylene	
1,2-Dichloropropane	

a. Source: Mann and Knobel (1987).

b. Detected above reporting level.

organics. Twelve compounds were detected in the samples, including carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, toluene, chloroform, 1,1-dichloroethylene, dichlorodifluoromethane, benzene, 1,2-dichlorobenzene, 1,2-trans-dichloroethylene, and 1,1-dichloroethane. Compounds detected in aquifer wells near the RWMC included carbon tetrachloride, chloroform, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, dichlorodifluoromethane, and 1,1-dichloroethane.

The analytical results reported by Mann and Knobel (1987) and its supplement were those values at or above their reporting level, which may be equivalent to the method quantitation limit. Therefore, the reporting level values of 3.0 µg/L (June 1987 samples) and 0.2 µg/L (all other samples) are considered method quantitation limits.

The Mann and Knobel (1987) study sampled 81 wells across the 890 mi<sup>2</sup> of the INEL. Twenty-one of the wells sampled are pertinent to the SDA. Eight of these wells represent regionally upgradient groundwater (see Section 2.2.4.2), eight wells are near the SDA, and five wells represent regionally downgradient groundwater. These wells are shown on Figures 3-4 and 3-5. The discussion below focuses on each of these three well groupings and presents all available sampling results from Mann and Knobel (1987) regarding these wells.

The following eight wells that were sampled in the Mann and Knobel study (1987) and its supplement are located to the north and east of the SDA, and might be considered to represent regionally upgradient groundwater (see Figure 3-6):

- Well 83                      • CFA-1
- Well 103                    • CFA-2
- Well 104                   • EBR-I Production Well
- Well 106                   • Highway 3.

Of the eight wells, three (83, 103, and 104) had no detectable volatile organics. Two wells (CFA-1 and CFA-2) contained 1,1,1-trichloroethane at 0.7 and 0.8 µg/L, and three wells (CFA-1, CFA-2, and Highway 3) contained trichloroethylene at 0.3 to 0.8 µg/L. Well EBR-1 contained dichlorodifluoromethane at 0.2 µg/L and Highway 3 well contained toluene at 5.2 µg/L. The field blanks contained 0.2 µg/L of toluene and 1,1,1-trichloroethane and 0.5 µg/L of chloroform.

The following eight wells are near the SDA (Figure 3-7):

- Well 87                      • Well 117
- Well 88                      • Well 119
- Well 89                      • Well 120
- Well 90                      • RWMC production well.

All eight of the wells near the SDA contained VOCs. The analytical results are presented in Table 3-9. The replicate samples collected show good same-day correlation. The field blank analyses detected chloroform at 0.5 µg/L, 1,1,1-trichloroethane at 0.2 µg/L, total xylenes up to 0.9 µg/L, methylene chloride at 1.4 µg/L, bromoform at 2.8 µg/L, dibromochloromethane at 0.3 µg/L, 1,2-dichloroethane at 0.8 µg/L, and toluene up to 1.4 µg/L.

As shown in Table 3-9, carbon tetrachloride and trichloroethylene are the most widely detected organics in the groundwater at SDA. Carbon tetrachloride was detected in 32 of 55 samples and trichloroethylene was detected in 28 of 55 samples. Concentrations of carbon tetrachloride found in perched waters were compared to computed values using Henry's Law, and good agreement was found (Hubbell, 1990). The compounds detected in decreasing order of maximum concentrations are: carbon tetrachloride (6.6 µg/L); trichloroethylene (1.4 µg/L); toluene (1.2 µg/L); chloroform

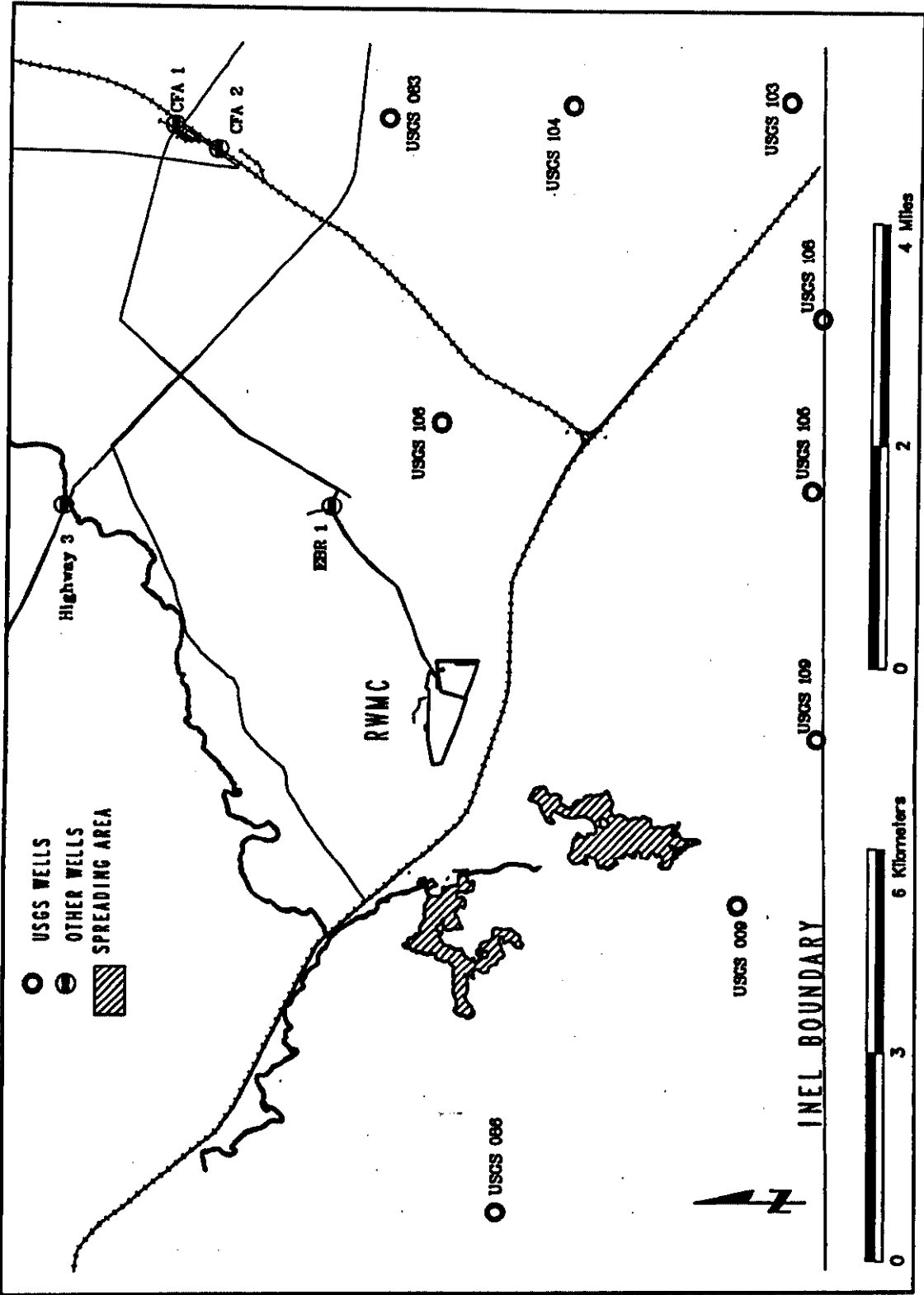


Figure 3-6. Groundwater wells outside the RWMC (EG&G 1988).



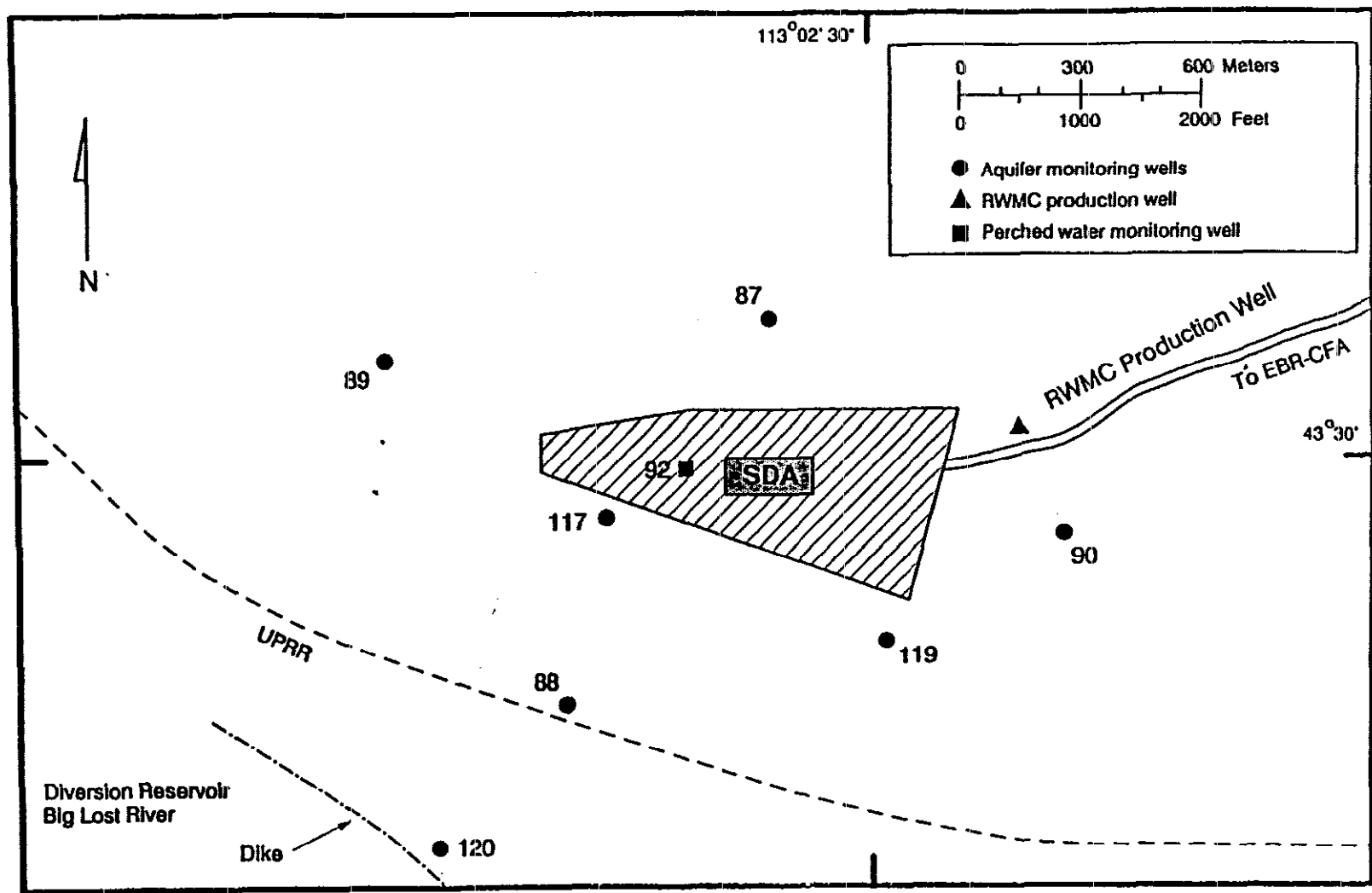


Figure 3-7. Approximate location of wells in the RWMC groundwater monitoring network.

**Table 3-9. Volatile organics in wells around the SDA<sup>a,b</sup>**

Well	Date	Carbon tetra- chloride (µg/L)	Chloroform (µg/L)	1,1,1- Trichloro- ethane (µg/L)	Trichloro- ethylene (µg/L)	Tetrachloro- ethylene (µg/L)	Dichloro- difluoro- methane (µg/L)	Toluene (µg/L)	1,1- Dichloro- ethane (µg/L)	1,1- Dichloro- ethylene (µg/L)
87	06/03/87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08/11/87	<u>0.3</u>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	09/23/87	<u>0.7</u>	<0.2	<0.2	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	04/06/88	<u>0.4</u>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	06/22/88	<0.2	<0.2	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	10/18/88	<u>0.6</u>	<0.2	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
88	06/03/87	<u>6.6</u>	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	07/08/87 <sup>c</sup>	<u>2.7-3.2</u>	<0.2	<u>0.6-0.7</u>	<u>1.1-1.2</u>	<u>0.2</u>	<0.2-0.3	<0.2	<0.2	<0.2
	07/15/87	<u>4.4</u>	<u>1.0</u>	<u>0.9</u>	<u>1.4</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	08/11/87	<u>2.1</u>	<u>0.4</u>	<u>0.4</u>	<u>1.2</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	09/22/87	<u>2.9</u>	<u>0.7</u>	<u>0.5</u>	<u>1.1</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	04/05/88 <sup>d</sup>	<u>2.5</u>	<u>0.5</u>	<u>0.6</u>	<u>1.1</u>	<u>0.2</u>	<u>0.4</u>	<0.2	<0.2	<0.2
		<u>2.3</u>	<u>0.5</u>	<u>0.6</u>	<u>1.0</u>	<0.2	<u>0.4</u>	<0.2	<0.2	<0.2
	06/24/88 <sup>d</sup>	<u>4.1</u>	<u>0.6</u>	<u>0.8</u>	<u>1.2</u>	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2
		<u>4.1</u>	<u>0.6</u>	<u>0.8</u>	<u>1.2</u>	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2
	09/29/88	<u>1.9</u>	<u>0.4</u>	<u>0.4</u>	<u>0.9</u>	<0.2	<u>0.2</u>	<0.2	<0.2	<0.2
89	06/03/87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08/12/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	09/22/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	02/01/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>0.8</u>	<0.2
	04/05/88	<0.2	<0.2	<0.2	<0.2	<0.2	<u>0.3</u>	<0.2	<0.2	<0.2
	06/24/88	<0.2	<0.2	<0.2	<0.2	<u>0.3</u>	<0.2	<0.2	<0.2	<0.2
	10/18/88	<0.2	<0.2	<0.2	<0.2	<0.2	<u>0.4</u>	<0.2	<0.2	<0.2

Table 3-9. (continued).

Well	Date	Carbon tetra- chloride (µg/L)	Chloroform (µg/L)	1,1,1- Trichloro- ethane (µg/L)	Trichloro- ethylene (µg/L)	Tetrachloro- ethylene (µg/L)	Dichloro- difluoro- methane (µg/L)	Toluene (µg/L)	1,1- Dichloro- ethane (µg/L)	1,1- Dichloro- ethylene (µg/L)
90	06/03/87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08/11/87	<u>0.6</u>	<0.2	<u>0.2</u>	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	09/23/87	<u>0.8</u>	<0.2	<u>0.2</u>	<u>0.3</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	04/06/88	<u>0.7</u>	<0.2	<0.2	<u>0.3</u>	<0.2	<u>0.3</u>	<0.2	<0.2	<0.2
	08/22/88	<u>1.0</u>	<0.2	<u>0.3</u>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	10/18/88 <sup>d</sup>	<u>0.7</u>	<0.2	<u>0.2</u>	<u>0.3</u>	<0.2	<u>1.6</u>	<0.2	<0.2	<0.2
		<u>0.8</u>	<0.2	<u>0.2</u>	<u>0.3</u>	<0.2	<u>1.1</u>	<0.2	<0.2	<0.2
	117	10/19/87 <sup>d</sup>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>0.3</u>	<0.2
<0.2			<0.2	<0.2	<0.2	<0.2	<0.2	<u>0.4</u>	<0.2	<0.2
11/05/87		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
02/01/88		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
04/05/88		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
06/27/88 <sup>e</sup>		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
10/17/88		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
19		11/06/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>1.2</u>	<0.2
	11/06/87 <sup>d</sup>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>1.0</u>	<0.2	<0.2
	02/01/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	04/05/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	06/27/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	10/17/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
120	11/18/87	<u>1.5</u>	<0.2	<u>0.5</u>	<u>0.5</u>	<0.2	<0.2	<u>0.3</u>	<0.2	<0.2
	11/18/87	<u>1.4</u>	<0.2	<u>0.4</u>	<u>0.4</u>	<0.2	<0.2	<u>0.3</u>	<0.2	<0.2
	02/01/88	<u>1.9</u>	<u>0.2</u>	<0.2	<u>0.6</u>	<0.2	<0.2	<0.2	<0.2	<0.2

Table 3-9. (continued).

Well	Date	Carbon tetra- chloride ( $\mu\text{g/L}$ )	Chloroform ( $\mu\text{g/L}$ )	1,1,1- Trichloro- ethane ( $\mu\text{g/L}$ )	Trichloro- ethylene ( $\mu\text{g/L}$ )	Tetrachloro- ethylene ( $\mu\text{g/L}$ )	Dichloro- difluoro- methane ( $\mu\text{g/L}$ )	Toluene ( $\mu\text{g/L}$ )	1,1- Dichloro- ethane ( $\mu\text{g/L}$ )	1,1- Dichloro- ethylene ( $\mu\text{g/L}$ )
RWMC	04/05/88	<u>1.5</u>	<0.2	<u>0.4</u>	<u>0.5</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	06/27/88 <sup>f</sup>	<u>2.1</u>	<u>0.2</u>	<u>0.5</u>	<u>0.5</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	10/18/88	<u>1.1</u>	<0.2	<u>0.2</u>	<u>0.3</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	06/03/87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	08/11/87	<u>1.0</u>	<0.2	<u>0.2</u>	<u>0.5</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	09/23/87	<u>1.3</u>	<0.2	<u>0.3</u>	<u>0.5</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	10/14/87	<u>1.5</u>	<0.2	<u>0.5</u>	<u>0.6</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	02/18/88 <sup>d</sup>	<u>1.2</u>	<0.2	<u>0.3</u>	<u>0.6</u>	<0.2	<0.2	<0.2	<0.2	<0.2
		<u>1.1</u>	<0.2	<u>0.3</u>	<u>0.6</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	04/06/88	<u>1.1</u>	<0.2	<u>0.4</u>	<u>0.5</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	07/21/88	<u>1.4</u>	<0.2	<u>0.4</u>	<u>0.6</u>	<0.2	<0.2	<0.2	<0.2	<0.2
	10/28/88	<u>1.0</u>	<0.2	<0.2	<u>0.5</u>	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2
	11/28/88	<u>1.1</u>	<0.2	<u>0.3</u>	<u>0.5</u>	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2
	12/28/88	<u>1.5</u>	<0.2	<u>0.4</u>	<u>0.7</u>	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2
Blank	10/07/87	<0.2	<u>0.5</u>	<0.2	<0.2	<0.2	<0.2	<u>0.2</u>	<0.2	<0.2
	10/15/87	<0.2	<u>0.5</u>	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	01/05/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>0.6</u>	<0.2	<0.2
	02/01/88 <sup>g</sup>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>1.4</u>	<0.2	<0.2
Blank	02/18/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	04/07/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	05/18/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	06/24/88 <sup>h</sup>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>1.3</u>	<0.2	<0.2

**Table 3-9.** (continued).

Well	Date	Carbon tetra- chloride ( $\mu\text{g/L}$ )	Chloroform ( $\mu\text{g/L}$ )	1,1,1- Trichloro- ethane ( $\mu\text{g/L}$ )	Trichloro- ethylene ( $\mu\text{g/L}$ )	Tetrachloro- ethylene ( $\mu\text{g/L}$ )	Dichloro- difluoro- methane ( $\mu\text{g/L}$ )	Toluene ( $\mu\text{g/L}$ )	1,1- Dichloro- ethane ( $\mu\text{g/L}$ )	1,1- Dichloro- ethylene ( $\mu\text{g/L}$ )
	06/29/88 <sup>i</sup>	<0.2	<u>0.3</u>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	10/03/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>0.2</u>	<0.2	<0.2
Spike	02/18/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

a. Mann et al. 1987; Mann 1989.

b. Reporting level = 3.0  $\mu\text{g/L}$  (6/87 samples), 0.2  $\mu\text{g/L}$  (all other samples). Detections are underlined.

c. Range of five samples taken at 40-240 min of pumping.

d. Quality assurance replicate.

e. Methylene chloride, 1.7.

f. Bromoform, 1.0.

g. Total xylenes, 0.2.

h. Methylene chloride, 1.4; total xylenes, 0.9.

i. 1,2-Dichloroethane, 0.8; bromoform, 2.8; dibromochloromethane, 0.3.

(1.0  $\mu\text{g/L}$ ); and 1,1,1-trichloroethane (0.9  $\mu\text{g/L}$ ). Samples collected from Well 88 show the most persistent detection of volatile organics over time and the widest range of detected volatile organics.

The following five wells are located regionally downgradient (south and west) of the SDA but are still within the INEL boundary (see Figure 3-6):

- Well 9
- Well 108
- Well 86
- Well 109.
- Well 105

Table 3-10 presents the analytical results for these wells. Three wells (86, 105, and 108) contained no detectable organic compounds. Toluene was the only volatile organic detected in these wells (0.3 to 1.0  $\mu\text{g/L}$ ).

Wells 87, 88, 89, 90, 117, 119, and 120 as well as the RWMC production well are located within 1 mi of the SDA (see Figure 3-7) and represent the wells that are the most pertinent to assessing the present extent of organic contamination at the SDA. The following discussion pertains to the data collected from these wells near the SDA. These data are presented on Table 3-9 and are used in conjunction with hydrologic information to evaluate organic contaminant distribution and variation over time in a preliminary, qualitative manner.

Table 3-11 presents the regulatory standards, criteria, and guidance that are most pertinent to the five organic chemicals most commonly detected at the SDA: carbon tetrachloride, chloroform, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene. Included in this table are Federal primary drinking water standards [maximum contaminant levels (MCLs)], Federal drinking water maximum contaminant level goals (MCLGs), and Federal ambient water quality criteria for human health adjusted for drinking water only.

Table 3-12 compares the data for groundwater organics samples from around the SDA with the criteria identified in Table 3-11. Analyses of only one sample found any organic chemical above the Federal primary drinking water standard (maximum concentration level), i.e., carbon tetrachloride. Carbon tetrachloride, tetrachloroethylene, and trichloroethylene were all found in various samples above the Federal MCLGs. It should be noted that the MCLG for each of these chemicals is zero. Carbon tetrachloride and chloroform were found above the ambient water quality criteria in several samples.

The samples collected in June 1987 were analyzed with a detection limit of 3  $\mu\text{g/L}$ . Only carbon tetrachloride was detected during that sampling episode. Subsequent sampling episodes used an analytical method with a detection limit of 0.2  $\mu\text{g/L}$  and detected carbon tetrachloride, trichloroethylene, 1,1,1-trichloroethane, chloroform, and tetrachloroethylene at various times and locations at concentrations less than 3  $\mu\text{g/L}$  (refer to Table 3-9). Thus, it is not possible to determine whether trichloroethylene, 1,1,1-trichloroethane, chloroform, and tetrachloroethylene were or were not present in June 1987 as the method reporting limit was not adequate for the concentrations that may have been present in groundwater. Since the June 1987 sampling, an organic chemical concentration of 3  $\mu\text{g/L}$  or greater has been detected three times (3.2, 4.1, and 4.4  $\mu\text{g/L}$ ) in USGS Well 88. These detections were in July 1987 and June 1988 for carbon tetrachloride.

**Table 3-10.** Volatile organics in wells south and west of the SDA.<sup>a,b</sup>

Well	Date	Carbon tetrachloride (µg/L)	Chloroform (µg/L)	1,1,1- Trichloro- ethane (µg/L)	Trichloro- ethylene (µg/L)	Tetrachloro- ethylene (µg/L)	Dichloro- difluoro- methane (µg/L)	Toluene (µg/L)	1,1- Dichloro- ethane (µg/L)	1,1- Dichloro- ethylene (µg/L)
9	07/30/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>0.3</u>	<0.2	<0.2
	10/15/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
86	08/04/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	10/06/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	06/22/88	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
105	07/30/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	09/28/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	09/28/87 <sup>c</sup>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
108	09/28/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
109	07/31/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>0.7</u>	<0.2	<0.2
	10/05/87	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<u>1.0</u>	<0.2	<0.2
Blank	10/07/87	<0.2	<u>0.5</u>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	10/15/87	<0.2	<u>0.5</u>	<u>0.2</u>	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

a. Mann et al. 1987; Mann 1989.

b. Detection limit = 0.2 µg/L, 3.0 µg/L (6/87 samples). Detections are underlined.

c. Quality assurance replicate.

**Table 3-11.** Regulatory standards, criteria, and guidance pertinent to groundwater concentrations of organics detected at the SDA.<sup>a</sup>

Chemical	Federal Primary Drinking Water Standards (MCLs) (µg/L)	Federal Drinking Water Maximum Contaminant Level Goals (µg/L)	Federal Ambient Water Quality Criteria for Human Health Adjusted for Drinking Water Only (µg/L)
Carbon tetrachloride	5	0	0.42 <sup>b</sup>
Chloroform	100	—	0.19 <sup>b</sup>
Tetrachloroethylene	5 <sup>c</sup>	0 <sup>d</sup>	0.88 <sup>b</sup>
1,1,1-Trichloroethane	200	—	19,000
Trichloroethylene	5	0	2.8 <sup>b</sup>

a. EG&G Idaho 1988.

b. Federal ambient water quality criteria for potential carcinogens corresponding to the 10<sup>-6</sup> risk level.

c. Proposed MCL (54 FR 22064).

d. Proposed MCLG (50 FR 46936).



**Table 3-12.** Number of SDA samples with organic constituent concentrations exceeding regulatory standards criteria or guidance.<sup>a</sup>

Chemical	Federal Primary Drinking Water Standards (MCLs)	Federal Drinking Water Maximum Contaminant Level Goals	Federal Ambient Water Quality Criteria for Human Health Adjusted for Drinking Water Only	Number of samples taken from 6/3/87 to 12/28/88
Carbon tetrachloride	Sample <sup>a</sup>	32 samples <sup>c</sup>	30 samples	55 samples
Chloroform	None	—	8 samples <sup>b</sup>	55 samples
Tetrachloroethylene	None	7 samples <sup>c</sup>	None	55 samples
1,1,1-Trichloroethylene	None	—	None	55 samples
Trichloroethylene	None	28 samples <sup>c</sup>	None	55 samples

a. This excludes the samples from well 92, which represents a discontinuous perched zone rather than the aquifer.

b. The analytical detection limit was higher than the regulatory standard; thus, the status of the samples that did not detect the compounds is indeterminate.

c. The goal is zero. The analytical detection limit is higher than the regulatory guidance; thus, the status of the samples that did not detect the compounds is indeterminate.

The range of concentrations found near the SDA for carbon tetrachloride, trichloroethylene, 1,1,1-trichloroethane, chloroform, and tetrachloroethylene are shown on Figures 3-8 to 3-12, respectively. The areas of detection are outlined on the figures. Carbon tetrachloride was not detected in Well 89, which is the western-most well, nor in Wells 117 and 119, which are located at the southern boundary of the SDA. Wells 88, 120, and the RWMC Production Well most consistently detected carbon tetrachloride in the sampling episodes. Well 120 lies southwest (regionally downgradient) of Well 88.

Trichloroethylene concentrations remained rather consistently low throughout the sampling period as shown in Table 3-9. Trichloroethylene shows a pattern similar to that for carbon tetrachloride in that it is found most consistently and at the highest concentrations in Wells 88, 120, and the RWMC Production Well.

1,1,1-Trichloroethane (Table 3-9) shows the same pattern of detection as carbon tetrachloride and trichloroethylene. Chloroform has only been detected in Wells 88 and 120 (see Table 3-9). Field blanks contained chloroform at concentrations similar to those in Table 3-9; thus, the analytical results for chloroform are questionable. Tetrachloroethylene was detected in Wells 88, 89, and the RWMC Production Well (Figures 3-9 and 3-12). However, the concentrations of tetrachloroethylene detected were all very close to method quantitation limits.

The EPA Technical Enforcement Guidance Document for groundwater monitoring indicates submersible pumps are not acceptable for collection of volatile organic compounds. The use of a submersible pump for water sampling may aerate the sample and possibly volatilizing organic compounds, thereby giving a possible indication of lower concentrations in the aquifer than are actually present. However, a recent USGS study at the INEL showed no detectable difference in VOC concentrations in the SRPA between samples taken with a submersible or a piston sampling pump.<sup>e</sup>

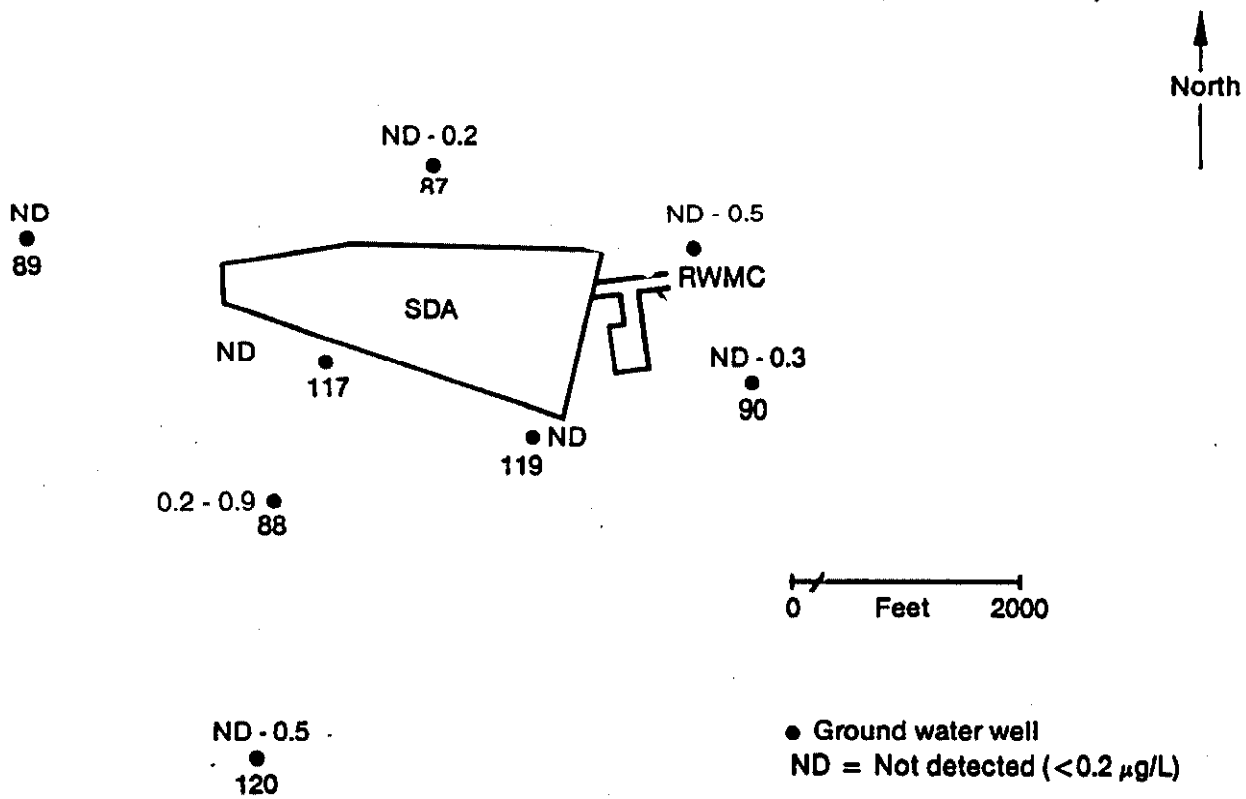
Submersible pumps will be used to sample and purge the SRPA monitor wells. The overall distribution of organics around the SDA is influenced by the complex hydrology of the area. This local hydrology is influenced by recharge of water into the Big Lost River diversion area, the fracture-dominated geology, and the regional Snake River Plain Aquifer. The distribution of purgeable organics around the SDA does not appear to be consistent with a "normal" release (Hubbell 1990). Wells north, east, and south of the SDA contain some organic contamination, but Wells 117 and 118, located immediately to the south of the SDA, have not detected any organic compounds. The cause of this is unknown but may be related to migration pathways of water from the diversion areas or to the wells not being in good communication with the uppermost part of the aquifer where these contaminants might persist.

### **3.3.3 Vadose Zone Investigations**

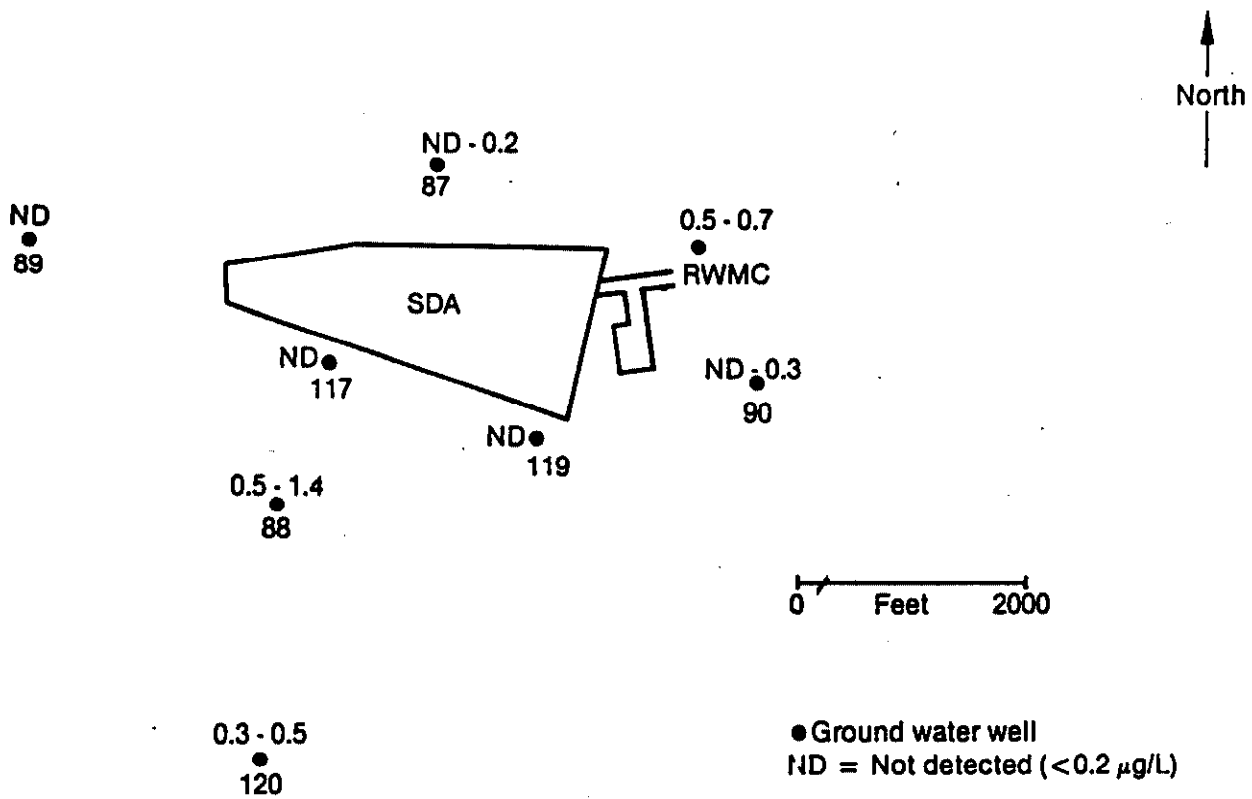
The vadose zone at the SDA refers to the unsaturated zone above the water table located at approximately 580 ft below the ground surface. The vadose zone consists of unconsolidated surficial sediments and soils, underlying olivine basalt flows, and thin sedimentary deposits interbedded with the basalts (Section 2.2.5).

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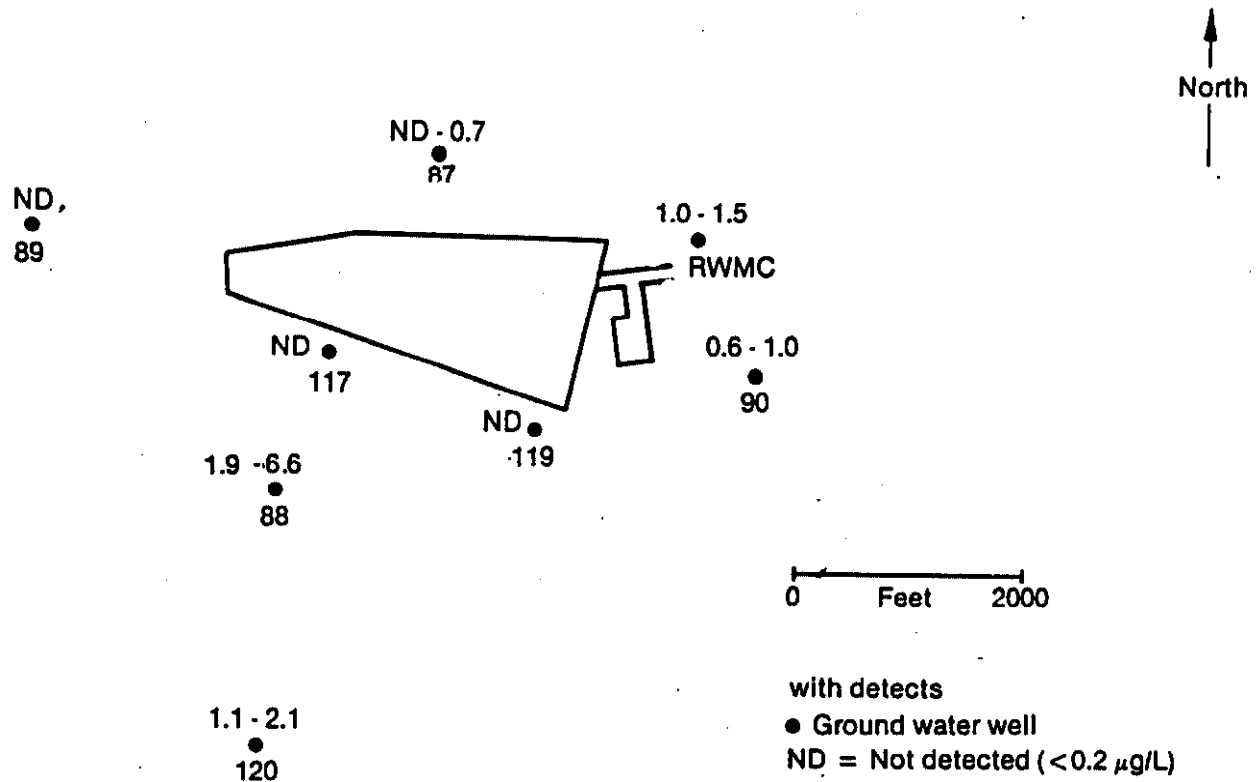
e. Personal communication from Larry Mann, April 1992. Draft report in review process.



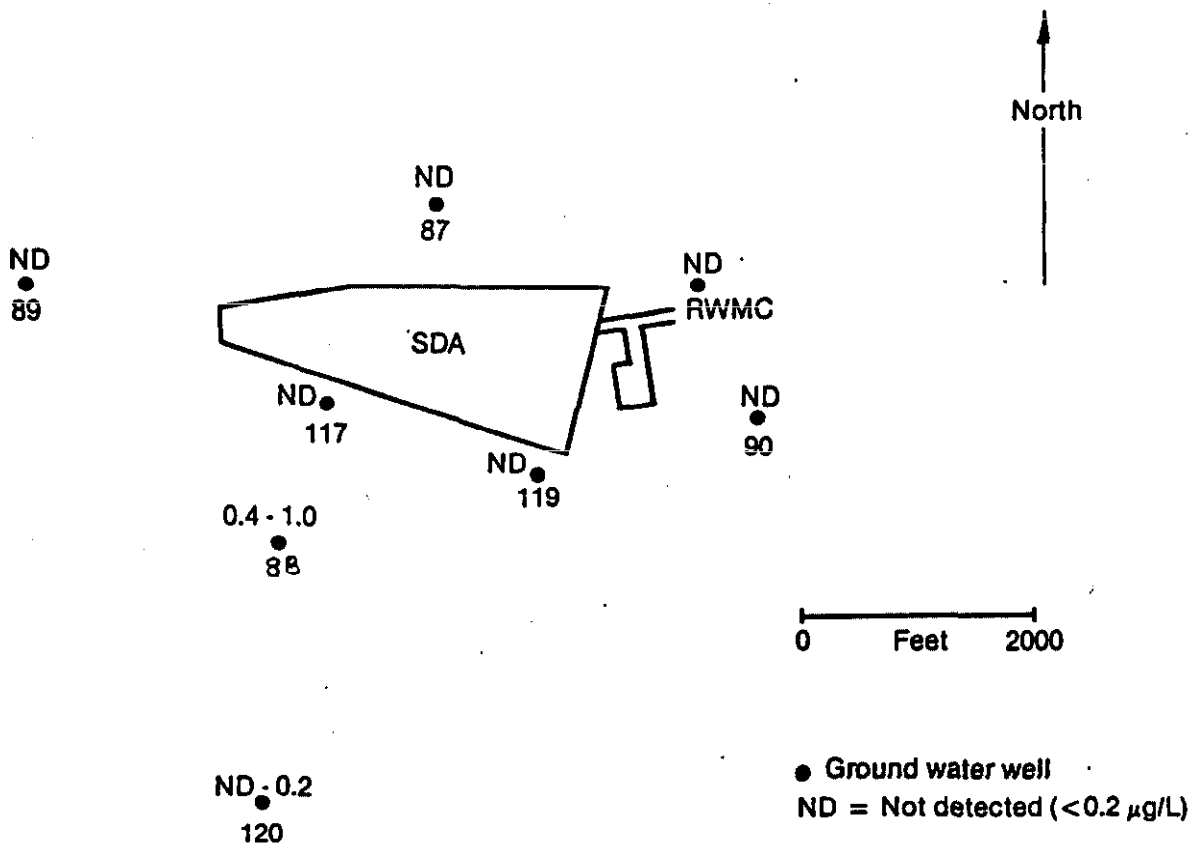
**Figure 3-8.** Range of concentrations of 1,1,1-trichloroethane from June 1987 to December 1988 (Hubbell 1989).



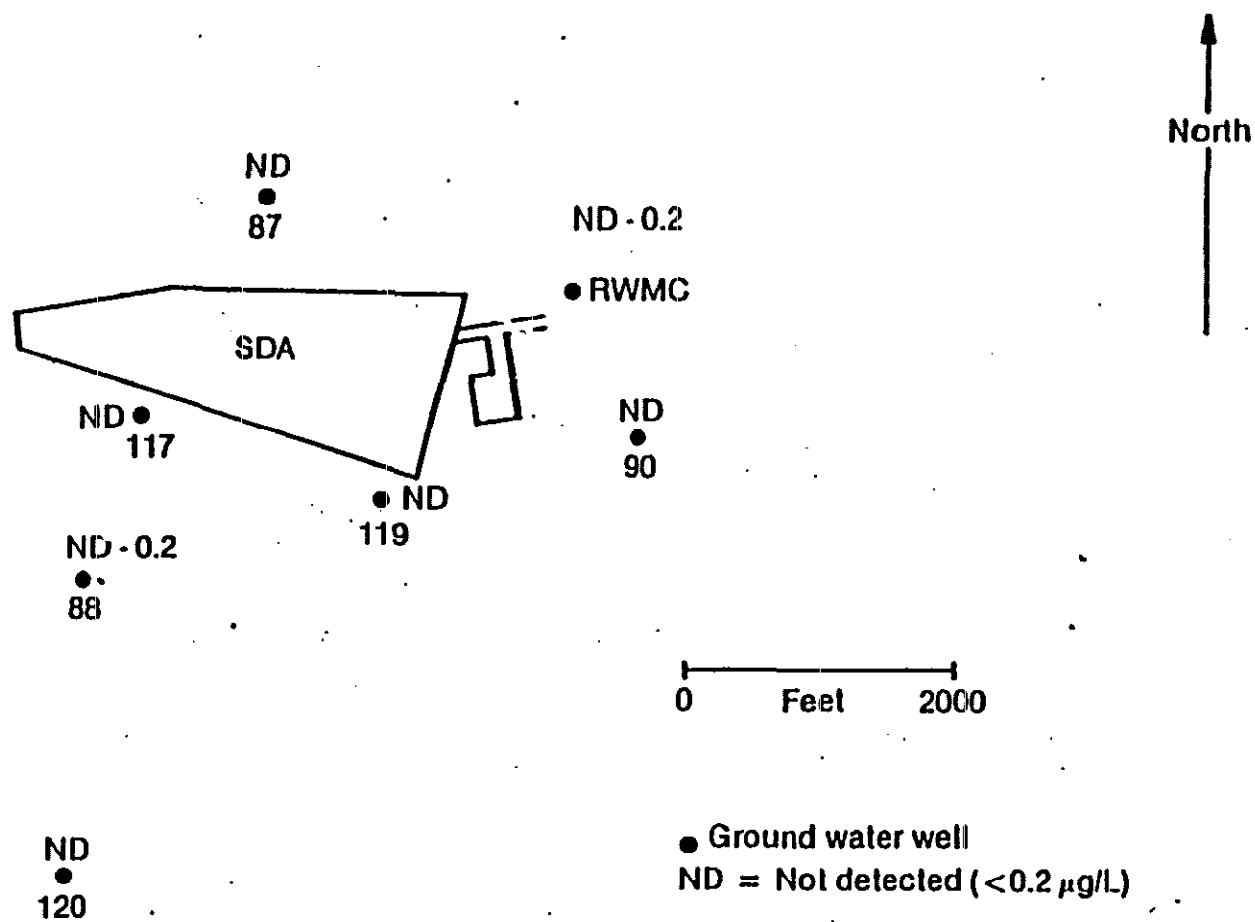
**Figure 3-9.** Range of concentrations of trichloroethylene from June 1987 to December 1988 (Hubbell 1989).



**Figure 3-10.** Range of concentrations of carbon tetrachloride from June 1987 to December 1988 (Hubbell 1989).



**Figure 3-11.** Range of concentrations of chloroform from June 1987 to December 1988 (Hubbell 1989).



**Figure 3-12.** Range of concentrations of tetrachloroethylene from June 1987 to December 1988 (Hubbell 1989).

Contained within the geologic media of the vadose zone are vapor and liquid phases. Locally the liquid phase approaches and reaches water saturation so that perched water zones form. Some perched groundwater zones appear to be permanent phenomena, such as found at Well 92 (Figure 2-38), whereas other perched zones may be transient features (Humphrey 1980).

This section presents an overview of previous investigations that address various aspects of the vadose zone, discusses organic analyses in soils, reviews wellhead gas analyses and a soil-gas survey, discusses soil water chemistry and perched groundwater chemistry, and summarizes other investigations including geophysical studies. Discussions incorporate results of analyses from specific sampling locations within the SDA and several data tables are presented in Tables 3-13 through 3-15. The location of wells and disposal pits and trenches at the SDA is shown on Figure 3-13.

**3.3.3.1 Previous Investigations.** Previous investigations of the vadose zone at the SDA have included efforts to characterize the hydraulic properties of the unsaturated zone, as well as analyze for organic contaminants. These efforts have been undertaken to establish potential sources of contamination, as well as evaluate potential pathways of migration for contaminants. The results of these investigations have included a variety of levels of effort to integrate and assess previous data. At this time, data are included in a variety of investigation-specific and program progress reports. No all-inclusive compilation of vadose zone information has been done.

Vadose zone investigations began in 1960 and are still in progress as part of an ongoing subsurface investigation program initiated in 1985. Previous investigations of the SDA vadose zone have been conducted by several organizations including the USGS and EG&G Idaho, often in joint investigations and by several subcontractors. A significant effort is currently under way to characterize and study the vadose zone at the RWMC. Several draft reports have been issued recently concerning the status and interim results of these studies. A summary of known previous and ongoing investigations of the vadose zone at the SDA is shown as Table 3-16.

The subsurface investigation plan that had focused on subsurface geology and hydrology and assessing radionuclide migration was expanded to include volatile organic contamination. This expansion occurred because VOCs were detected beneath the SDA. This focus on volatile organic contamination included simulate organic vapor transport in the subsurface (Laney et al. 1988), a soil-gas survey, groundwater monitoring, and air sampling programs. A study of organics in groundwater from the Snake River Plain Aquifer was conducted during June through November 1987 at the INEL (Mann and Knobel 1987). The analytical results of organics from one perched water sample collected during that program in October 1987 from a discontinuous perched water zone 345 ft above the Snake River Plain Aquifer at Well 92 are presented in Table 3-17. A sample from Well 8802D was obtained in July 1989. The VOC analyses from this period are presented in Table 3-17.

Dichlorodifluoromethane and toluene were not detected above the reporting level of 0.2 µg/L (Mann and Knobel 1987). When concentrations of carbon tetrachloride in the perched waters were compared to values predicted from Henry's Law, reasonable agreement was found. This result indicated that the aqueous and gaseous phases were not in equilibrium. If the phases were not in equilibrium, it would indicate that perched water could be from a source other than percolation from the area inside the SDA.



**Table 3-13.** Vapor concentrations for grab air samples from Borehole D02.<sup>a</sup>

Chemical	Date of sampling (1987)		Reporting limit (mg/m <sup>3</sup> )
	September 25 (mg/m <sup>3</sup> )	September 29 (mg/m <sup>3</sup> )	
Carbon tetrachloride	900	1000	5
Chloroform	210	230	5
1,1-Dichloroethane	(3)	(3)	5
Tetrachloroethylene	20	62	5
Toluene	ND	(0.3)	5
1,1,1-Trichloroethane	95	120	5
Trichloroethylene	220	380	5
1,1,2-Trichlorotrifluoroethane	20	65	5

a. Letter from G. S. Groenwold and P. N. Pink to T. Hedahl, 1987, "Sampling and Analysis of RWMC SDA Air, Soil, and Well Gas," GSG-63-87, EG&G Idaho.

ND = not detected.

( ) = detected below reporting limit.

**Table 3-14.** Vapor concentrations for grab air samples from Borehole D10.<sup>a</sup>

Chemical	Date of sampling (1987) (duplicate samples)		Reporting limit
	September 25 (mg/m <sup>3</sup> )	September 29 (mg/m <sup>3</sup> )	
Carbon tetrachloride	130, 140	200	5
Chloroform	9, 12	(4)	5
1,1-Dichloroethane	ND, ND	ND	5
Tetrachloroethylene	9, 9	7	5
Toluene	ND, ND	ND	5
1,1,1-Trichloroethane	14, 15	11	5
Trichloroethylene	34, 38	17	5
1,1,2-Trichlorotrifluoroethane	(2, 3)	6	5

a. Letter from G. S. Groenwold and P. N. Pink to T. Hedahl, 1987, "Sampling and Analysis of RWMC SDA Air, Soil, and Well Gas," GSG-63-87, EG&G Idaho.

ND = not detected.

( ) = detected below reporting limit.

**Table 3-15.** Vapor concentrations for grab air samples from Well 89.<sup>a</sup>

Chemical	Date of Sampling (1987) September 25 (mg/m <sup>3</sup> )	Reporting limit (mg/m <sup>3</sup> )
Carbon tetrachloride	8	5
Chloroform	(1)	5
1,1-Dichloroethane	ND	5
Tetrachloroethylene	(.04)	5
Toluene	ND	5
1,1,1-Trichloroethane	(0.8)	5
Trichloroethylene	(3)	5
1,1,2-Trichlorotrifluoroethane	ND	5

a. Letter from G. S. Groenwold and P. N. Pink to T. Hedahl, 1987, "Sampling and Analysis of RWMC SDA Air, Soil , and Well Gas," GSG-63-87, EG&G Idaho.

ND = not detected.

( ) = detected below reporting limit.

**Figure 3-13.** Location of wells and waste disposal pits and trenches at the SDA (Rightmire and Lewis 1987).

**Table 3-16.** Summary of previous vadose zone investigations.

Investigation/reference	Objectives	Field activities	Results	Conclusions
<i>Geophysical Surveys at INEL/RWMC Cold Pit, Acid Pit, and Pit 9 DDC, Geotech 1989</i>	Define the boundaries of three pits, locate the 3,000-gal tank thought to be buried in the Acid Pit, and locate and identify other debris within the pits.	Ran total magnetic, magnetic gradient, EH conductivity, EH inphase, VIF EH, and seismic refraction to define pit boundaries, locate 3,000-gal tank, and locate metallic and cultural debris in and around pits.	All pit boundaries outlined; presence of 3,000-gal tank not confirmed; metallic debris delineated in Cold Pit and Pit 9, none detected in Acid Pit. No metallic debris detected adjacent to pits.	Induction EH and magnetic surveys successfully outlined pits and detected debris; should be used for further studies of other pits. Seismic refraction useful with no frozen ground. VIF EH data was not useful because of lack of resolution and is not recommended for further use.
<i>DWP: Pit 9 and Acid Pit Sampling SAP (Draft), EBASCO 1989.</i>	To find subsurface basalt/pit interface at Pit 9 and the Acid Pit.	Seismic refraction survey over the Acid Pit and Pit 9 to locate the pit/basalt interface.	Depth to basalt in Acid Pit between 15 ft and 21 ft; depth to basalt in Pit 9 between 10 ft and 18 ft.	Refraction successful in determining pit depths for subpit sampling. Refraction useful tool for finding pit depths at other pit locations.
<i>Feasibility of Shallow Seismic Reflection Methods Near the RWMC, KGS 1988.</i>	To determine the feasibility of using shallow reflection methods to locate subsurface interbeds.	Used seismic reflection to map shallow layers in repetitive basalt/sand environment.	A 3-4 m thick sedimentary layer located at approximately 30 m of depth.	Seismic reflection designed to specifically map the sedimentary interbed at 30 m was successful; shallow seismic reflection a useful tool for further investigation of geologic structure and stratigraphy at the RWMC.
<i>Draft Perched Groundwater at the RWMC, Idaho National Engineering Laboratory Idaho, Hubbell 1989.</i>	To summarize available data and status of information on perched groundwater at the RWMC.	None	Drilling data suggest perched zones not laterally or vertically extensive.	

**Table 3-17. Concentrations of purgeable organic compounds in Well 92 and 8802D.<sup>a,b,c</sup>**

Well number	Date sampled	Method	Carbon tetra-chloride (µg/L)	Chloro-form (µg/L)	1,1,1-Tri-chloro-ethane (µg/L)	Tri-chloro-ethylene (µg/L)	Tetra-chloro-ethylene (µg/L)	Dichloro-difluoro-methane (µg/L)	Toluene (µg/L)	1,1-di-chloro-ethane (µg/L)	1,1-di-chloro-ethylene (µg/L)	Refer-ence
92 (Ground water)	10/22/87 <sup>d</sup>		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	— <sup>b</sup>
	10/23/87 <sup>e</sup>		1,200	650	140	860	110	<0.2	<0.2	13	0.8	— <sup>b</sup>
	04/06/88 <sup>f</sup>	EPA 524	1,400	940	250	1,100	120	0.3	0.3	22	2.6	— <sup>c</sup>
8802D (Perched Water)	07/19/89		110	13	10	97	7	--	<5	<5	<5	— <sup>a</sup>

a. Hubbell 1990.

b. Mann and Knobel 1987.

c. Mann et al. 1988.

d. Equipment blank for well 92; it had 0.5 µg/L styrene.

e. Also reported 1,1,2,2-tetrachloroethane at 1.0 µg/L and 1,2-dichloropropane at 5.9 µg/L.

f. Also reported: Trichlorofluoromethane at 0.4 µg/L,  
1,2 - Dichloroethane at 1.6 µg/L,  
1,2 - Transdichloroethene at 1.7 µg/L,  
1,2 - Dichloropropane at 12 µg/L,  
Benzene at 0.2 µg/L.

Background information on the subsurface investigations program and activities completed to date is contained in DOE (1983), Hubbell et al. (1985 and 1987), Laney et al. (1988), McElroy et al. (1989), and Hubbell (1990). Sampling of soil, soil gas, and the sedimentary interbeds has resulted in the detection of radionuclides, organics, and inorganics in some of these environmental media. Table 3-18 lists all contaminants identified in the draft final report of the *Preliminary Remedial Action Objectives and Remediation Technologies for the SDA* (SAIC 1989) by environmental medium and maximum concentrations detected; however, the contaminants of interest for this program are the volatile organics.

Previous investigations have provided limited characterization of the site and have also helped focus the data gaps which are presented in Section 4.3.3. The Sampling and Analysis Plan (Attachment III) has been developed to fill these data gaps.

**3.3.3.2 Volatile Organic Analyses.** This section summarizes the existing, readily available data concerning VOCs that have been detected in the various media comprising the vadose zone below the SDA. Volatile organic contaminants have only recently been recognized in the SDA vadose zone, so the amount of data and its distribution according to the vadose media is less than data related to radionuclide and inorganic compounds.

The most comprehensive compendia of data concerning organic contaminants available during the preparation of this focused RI/FS plan were the Work Plan of the SDA (EG&G Idaho 1989), the RFI Work Plan (EG&G Idaho 1988) and the draft final report, *Preliminary Remedial Action Objectives and Remediation Technologies for the Subsurface Disposal Area* (SAIC 1989). The synopsis of data for this work plan relies heavily on those summarizations. In addition, other available environmental and analytical reports were used to determine what contaminants have been detected at the SDA. This review included various EG&G Idaho and DOE-Idaho reports, annual environmental summary reports, and miscellaneous sample analysis reports.

Environmental reports and analytical data were not available for all media or types of contaminants. In addition, some of the monitoring results have not received adequate quality assurance review. The following text primarily summarizes the SAIC RI/FS Work Plan of the SDA, RWMC at the INEL (EG&G Idaho 1989) review augmented by additional literature research. It presents the data available regarding organic contamination in the vadose zone at the SDA.

The SDA RI/FS Work Plan (EG&G Idaho 1989) reports that organic contaminants have been found in the soils, interbed sediments, perched groundwater, and soil gas and wellhead gas, although soil gas has been the most thoroughly sampled of these five vadose zone elements. The subsections that follow describe the reported detection of organic compounds in wellhead gas, soil gas, and perched groundwater. Of the compounds analyzed for, carbon tetrachloride is the organic contaminant found in the highest concentrations in the vadose zone. The reported maximum concentration is 2,300 µg/L in collected soil gas (Laney et al. 1988) and 5,800 mg/m<sup>3</sup> (5,800 µg/L) in borehole vapors during drilling (SAIC 1989a). The subsection reviewing the soil-gas survey conducted by Golder (1987) provides a more detailed discussion of organic contaminants. The other organic compounds detected at relatively high concentrations include 1,1,1-trichloroethane, trichloroethylene, and tetrachloroethylene. Table 3-18 contains summarized organic contaminant data for the vadose zone at the SDA.

**Table 3-18. VOC inorganic and radionuclide contaminants by environmental medium at the SDA.**

Medium	Organic	Concentration	Inorganic <sup>c</sup>	Concentration	Radionuclide	Concentration
Soil gas <sup>d</sup> survey	Carbon tetrachloride	1,400 µg/L			Am-241	1.54+/-0.03E-04 µCi/g
	1,1,1-Trichloroethane	310 µg/L			Eu-154	3.1+/-1.9E-08 µCi/g
	Trichloroethylene	690 µg/L			Cs-137	1.8+/-7WE-08 µCi/g
	Tetrachloroethylene	40 µg/L			Pu-238	3.8+/-0.4E-07 µCi/g
	Tetrachloroethane	40 µg/L			Pu-239, 240 in soil/water	3.34+/-0.06E-05 µCi/g
						8+/-7E-11 µCi/mL
					Pu-238 and/or Am-241 in soil/water	5.3+/-1.3E-10 µCi/g
					Sr-90	1.28+/-0.04E-06 µCi/g
					Co-60	
Air <sup>b</sup>	Carbon tetrachloride	5,800 mg/m <sup>3</sup>			Cs-137	0.7+/-02E-15 µCi/mL
	Chloroform	320 mg/m <sup>3</sup>			Sb-125	7.27+/-0.15E-14 µCi/mL
	Trichloroethylene	380 mg/m <sup>3</sup>			Am-241	3.5+/-0.7E-17 µCi/mL
	Tetrachloroethylene	62 mg/m <sup>3</sup>			Sr-90	3.2+/-0.6E-16 µCi/mL
	1,1,1-Trichloroethane	120 mg/m <sup>3</sup>			Pu-238	1.6+/-0.6E-17 µCi/mL
					Pu-239, 240	7.2+/-0.6E-16 µCi/mL
Perched water	Carbon Tetrachloride (w)	1,400 ppb	Arsenic	14.3 mg/kg	Cs-137	3+/-1.6E-08 µCi/g
	Chloroform (w)	940 ppb	Barium	392 mg/kg	Pu-239, 240	5.8+/-02E-08 µCi/g
	1,1,1-Trichloroethane (w)	250 ppb	Beryllium	1.4 mg/kg	Pu-239	8.110E-09 µCi/g
	Trichloroethylene (w)	1,100 ppb	Cadmium	8.4 mg/kg	Pu-238	3.22+/-0.17E-08 µCi/g
	Tetrachloroethylene (w)	120 ppb	Chromium	40.0 mg/kg	Am-241	8.010E-09 µCi/g
	Dichlorodifluoromethane (w)	0.3 ppb	Cobalt	14.4 mg/kg	Sr-90	6+/-E-08 µCi/g
	Toluene (w)	0.3 ppb	Lead	16.1 mg/kg		
	1,1-Dichloroethane (w)	22 ppb	Nickel	34.4 mg/kg		



**Table 3-18. (continued).**

Medium	Organic	Concentration	Inorganic <sup>c</sup>	Concentration	Radionuclide	Concentration
Ground <sup>c</sup> water	Carbon Tetrachloride	6.6 µg/L				
	Chloroform	1.0 µg/L				
	Trichloroethylene	1.4 µg/L				
	Tetrachloroethane	0.2 µg/L				
	1,1,1-Trichloroethane	0.9 µg/L				
	Dichlorodifluoromethane	0.3 µg/L				
	1,1-Dichloroethane	0.3 µg/L				
	1,1-Dichloroethylene (w)	2.6 ppb	Selenium	1.0 mg/kg		
	1,2-Dichloropropane (w)	5.9 ppb	Silver	2.4 mg/kg		
	1,1,2,2-Tetrachloroethane (w)	1.0 ppb	Thallium	2.4 mg/kg		
			Zinc	81.6 mg/kg		
			Cyanide	1.25 mg/kg		
			Tin	244 mg/kg		

a. Concentration values provided in this table are the highest observed values per medium as reported in the literature provided for this effort. Limited monitoring data were available for this review and, therefore, the contaminants and concentration reported in this table are not necessarily all-inclusive and should be used as a general indicator of the range of contamination at the RWMC. This list provides data only on compounds found above stated detection limits (i.e., estimated values are not included).

b. Ground level (Golder, 1987) air samples (Groenewold and Pink, 1987).

c. Groundwater samples (Mann and Knobel, 1987).

d. Reports results from soil-gas analyses.

w = Well 92 - perched water zone above the 240-ft interbed (Mann and Knobel, 1988).

Volatilization of organic compounds has been documented and the presence of a vapor plume is suspected as a contributor to the migration of contaminants at the Site (SAIC 1989). The full extent and magnitude of soil contamination is difficult to determine from the existing data.

**3.3.3.2.1 Grab Air Sampling from Wellheads.** Two air studies have been conducted at the SDA. One study involved the collection and analysis of air samples at wellheads to assess soil-gas concentrations associated with specific subsurface zones (EG&G Idaho 1988). The second study involved the collection and analysis of air samples at working levels above wellheads to assess worker exposure (EG&G Idaho 1988). The samples from these studies were collected in 25 mL Hamilton syringes, preserved, and analyzed according to the sampling, transport, and analysis method.<sup>f</sup> The sampling locations are shown in Figure 3-14. The analytical results are listed in Table 3-19. Results of the study related to soil-gas concentration in subsurface zones are discussed below.

During the drilling and instrumenting of two deep boreholes in 1987, organic vapor was detected at the ground surface (Laney et al. 1988). On September 24, 1987, organic vapors were detected when the casing in Borehole D02 (which had been installed at SDA during 1986) was pulled up and some of the 110-ft interbed was exposed in the borehole. The following day, vapor was detected emanating from Borehole D10 during drilling operations when a depth of 95 ft was reached, again assumed to be related to the 110-ft interbed.

Grab samples of air were collected from the wellheads at D02 and D10 on September 25, 29, and 30, 1987. The samples were analyzed by gas chromatography/mass spectrometry in the Chemical Sciences Laboratory at the INEL. The vapor concentrations measured in these samples are presented in Tables 3-13 and 3-14 for Boreholes D02 and D10, respectively (Laney et al. 1988).<sup>g</sup>

The reporting limits for these analyses were 5 mg/m<sup>3</sup> for each compound. Replicate samples were taken from Borehole D10, and the results indicated good overall precision for sampling and analysis. However, data precision between sampling events on different days was not as good as same-day sampling precision. This may be caused by the effects of barometric pressure on the movement of soil gas in and out of boreholes and wells.

Grab air samples were also collected from Well 89 on September 29, 1987. Well 89 had been cased and cemented to 576 ft, with several feet of open hole above the water table. Air samples were analyzed by gas chromatography/mass spectrometry at the INEL Chemical Sciences Laboratory, and five chlorinated hydrocarbons were detected as shown on Table 3-20 (Laney et al. 1988). The reporting limit for each compound was 5 mg/m<sup>4</sup>, and the only compound above reporting limits is carbon tetrachloride (Table 3-20). A comparison of the organics detected in each of the boreholes and wells indicated that carbon tetrachloride and trichloroethylene were the two compounds consistently found at the highest concentrations. Concentrations of carbon tetrachloride above 500 mg/m<sup>3</sup> are observed in dense basalts immediately above the 110-ft interbed, while concentrations of carbon tetrachloride less than 200 mg/m<sup>3</sup> are typical values for the basalts between the 110-ft and 240-ft interbeds. The detection of the same VOCs in well 89 as found in the vicinity of the 240-ft

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f. Letter from P. N. Pink to B. Chantrell, "Analytical Method Used for Volatile Organic Analyses of Air Samples," 1988.

g. EG&G Idaho letter from G. S. Groenewold and P. N. Pink to T. Hedahl, "Sampling and Analysis of RWMC SDA Air, Soil, and Well Gas," GSG-63-87, 1987.

3-50

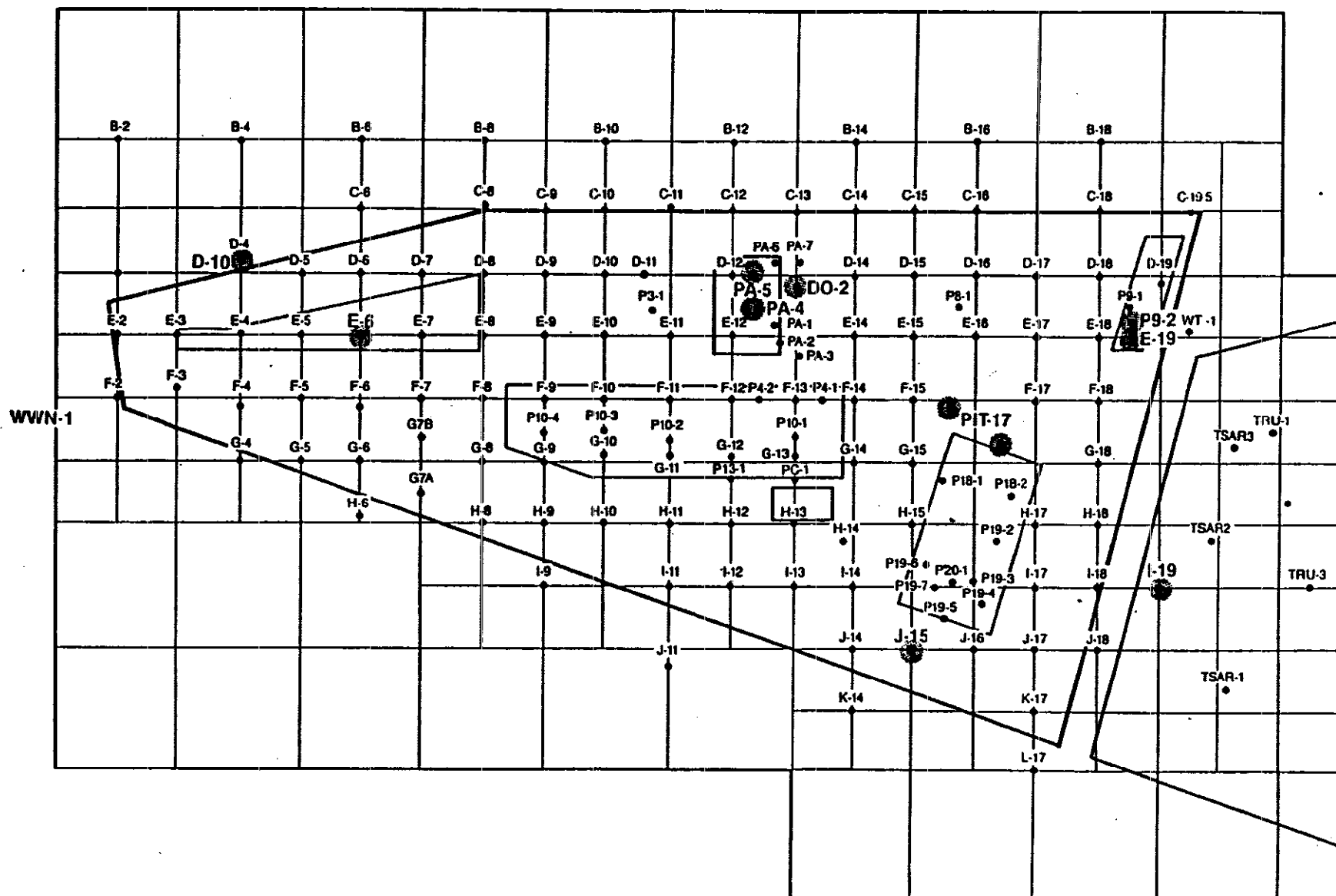


Figure 3-14. Location of grab air samples at the SDA overlay on the Golder (1987) soil gas survey grid.

**Table 3-19.** Vapor concentrations for grab air sample, 3-5 ft above ground (breathing zone).

Chemical	Sampling Location (9/30/87)										
	Practical Quantification Limit (mg/M <sup>3</sup> )	Borehole DO2 <sup>a</sup> (mg/M <sup>3</sup> )	Borehole D10 <sup>a</sup> (mg/M <sup>3</sup> )	Pad A Excavation Area(mg/M <sup>3</sup> )	Pad A Open Hole(mg/M <sup>3</sup> )	Pad A Subsidence Hole(mg/M <sup>3</sup> )	Pit 17 West Wall <sup>a</sup> (mg/M <sup>3</sup> )	Pit 17 South End (Blasting Area) <sup>a</sup> (mg/M <sup>3</sup> )	USGS Borehole 118 (mg/M <sup>3</sup> )	West Guard Gate (Control) <sup>a</sup> (mg/M <sup>3</sup> )	Method Blank (mg/M <sup>3</sup> )
Chloroform	5	(0.4)	(0.9)	(2.0)	ND	ND	(0.9), ND, ND	(0.8)	(0.8)	(0.9)	(0.1)
1,1,1-Trichloroethane	5	(0.4)	(1.0)	(1.0)	(2.0)	ND	(1.0), ND, ND	(1.0)	(1.0)	(2.0)	(0.2)
Carbon Tetrachloride	5	(3.0)	ND	17.0	ND	11.0	(b), ND, ND	(1.0)	ND	ND	ND
Trichloroethylene	5	(0.5)	ND	5.0	ND	5.0	ND, ND, ND	ND	(0.5)	ND	ND
Perchloroethylene	5	ND	ND	(0.5)	ND	(4.0)	ND, ND, ND	ND	ND	ND	ND
Toluene	5	ND	ND	(1.0)	ND	(0.2)	ND, ND, ND	ND	ND	ND	ND
Acetone	10	ND	ND	(5.0)	ND	ND	ND, ND, ND	ND	ND	ND	ND
Ethylbenzene	5	ND	ND	(0.4)	ND	ND	ND, ND, ND	ND	ND	ND	ND
2-Butanone	10	ND	ND	(1.0)	ND	ND	ND, ND, ND	ND	ND	ND	ND
1,1,2-trichloro-1,2,2-trifluoroethane	5	ND	ND	(2.0)	ND	(3.0)	ND, ND, ND	ND	ND	ND	ND

<sup>a</sup> Samples taken 3-5 feet above ground; other samples taken just above the soil surface.

b Value measured at 430 mg/M<sup>3</sup>, but was attributed to laboratory contamination.

( ) below PQL.

Reference: EG&G Idaho letter from G. S. Groenewold and P. N. Pink to T. Hedahl, "Sampling and Analysis of RWMC SDA Air, Soil, and Well Gas," GSG-63-87, 1987.

**Table 3-20.** Volatile organic analysis in the soil-gas survey.<sup>a</sup>

Volatile organic	Reporting limit (mg/L)	Lowest reporting limit (mg/L)
Benzene	1	—
Carbon tetrachloride	0.01	0.01
1,1-Dichloroethylene	0.6	—
trans-1,2-Dichloroethylene	0.6	—
1,2-Dichloropropane	0.6	—
trans-1,2-Dichloropropane	0.5	—
Methylene chloride	0.6	—
Tetrachloroethylene	0.01	0.01
Toluene	1	—
1,1,1-Trichloroethane	0.01	0.01
1,1,2-Trichloroethane	0.6	—
Trichloroethylene	0.01	0.01

a. Golder 1987.

interbed indicate the samples are from the same plume. Thus the observed differences in carbon tetrachloride concentrations between DO2 and D10 could have resulted from soil gases being vented from different basalt units. Well D10 is also farther from the VOC plumes found in soil-gas surveys; hence, the observed difference could be because of well location. Although the individual order varied for Boreholes D02 and D10, the four compounds found at the highest concentrations in borehole gases were:

- Carbon tetrachloride
- Trichloroethylene
- Chloroform
- 1,1,1-Trichloroethane.

Tetrachloroethylene and 1,1,2-trichlorotrifluoroethane were the next most frequently detected compounds. It is significant to note that carbon tetrachloride is the VOC that appears consistently as the highest concentration in groundwater as well as soil-gas samples.

**3.3.3.2.2 Soil-Gas Surveys.** Golder Associates performed a soil-gas survey of the SDA during the period of October 28 through November 6, 1987 (Golder 1987). The survey covered all of the SDA and about 600 ft beyond the SDA boundary. A total of 136 samples were collected on a grid with 200 ft spacing. An additional 63 samples were collected at supplemental sampling locations, including existing Wells 77-1, 78-1, and WWW-1, and an overlapping part of the TSA. A map of the gas survey sampling points is presented in Figure 3-15.

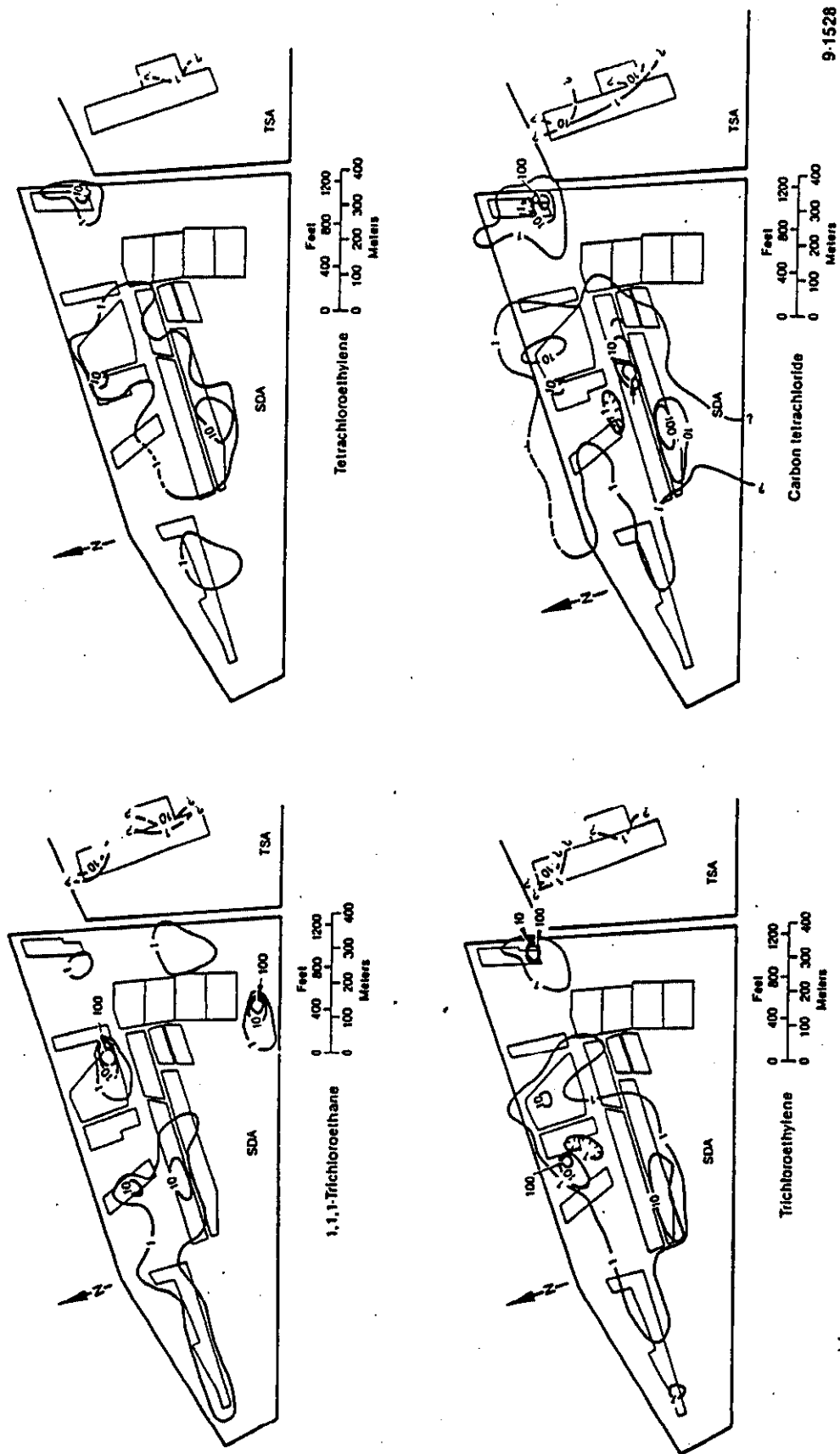
Soil-gas samples were collected from syringes inserted into steel probes driven 2 to 35 in. into the ground. The soil-gas samples collected were analyzed in the field by gas chromatography. The samples were analyzed for 12 VOCs, which are presented in Table 3-20. Chloroform could not be resolved from the large concentrations of carbon tetrachloride and 1,1,1-trichloroethane, therefore, chloroform may have been present but could not be specifically identified (Golder 1987).

Levels above the reporting limit were found for only four of the 12 compounds tested: carbon tetrachloride, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene. Isopleth maps of the concentrations of these four organics are presented in Figure 3-16 (adapted from Laney et al. 1988). In general, the highest concentrations of the four organics were found above Pits 4, 5, 6, 9, and 10, at Pad A, and between Trenches 25 and 33. The highest concentrations found were

- 2,300 µg/L of carbon tetrachloride at point P4-2 (Pit 6)
- 1,400 µg/L of carbon tetrachloride at point E-19 (Pit 9)
- 690 µg/L of trichloroethylene at point E-19 (Pit 9)
- 310 µg/L of 1,1,1-trichloroethane at point E-15 (Pit 5)
- 40 µg/L of tetrachloroethylene at point E-19 (Pit 9).

Two sets of soil-gas data collected by Golder (1987) over several days from two sampling points, E-15 and E-19, provide insight into the variability of the volatile organic measurements over the span of the study (Table 3-21). Soil-vapor concentrations of carbon tetrachloride, trichloroethylene, and tetrachloroethylene measured at sampling point E-19 on October 30 and 31 and November 2, 3, 4, and 5 all decreased from October 30 to minimum values on November 2, and then increased again on subsequent days. Concentrations of the four volatile organic analytes detected in the soil-gas survey varied in a similar manner. This similarity strongly suggests effects from an uncontrolled variable, such as the effect of barometric pressure on inhalation and exhalation of soil gas. Therefore, organic compound concentrations in vapors measured on different days are not comparable, and make precise mapping of contaminant vapors in the subsurface difficult (Golder 1987).





**Figure 3-16.** Isopleth maps of volatile organic compounds measured in soil gas at the RWMC (units in  $\mu\text{g/L}$ ) (Laney et al. 1988).



**Table 3-21.** Soil-gas volatiles: ratios of maximums to minimums for a six-day period.<sup>a</sup>

Date	Sampling point E-15				Sampling point E-19			
	1,1,1-TCA	CCl <sub>4</sub>	TCE	PCE	1,1,1-TCA	CCl <sub>4</sub>	TCE	PCE
Oct. 30	170	P	1.6	6	P	1,400	100	25
Oct. 31	48 <sup>b</sup>	5	0.8	5.2	P	1,200	100	21
Nov. 2	120	<0.01 <sup>b</sup>	0.08 <sup>b</sup>	3 <sup>b</sup>	P	640 <sup>b</sup>	80 <sup>b</sup>	20 <sup>b</sup>
Nov. 3	280	P	3.2	7	P	900	690	30
Nov. 4	310	<0.01	4	7	<0.01 <sup>b</sup>	1,000	150	40
Nov. 5	—	—	—	—	P	1,230	200	34
Maximum	310	5	4	7	P	1,400	690	40
Maximum	48	<0.01	0.08	3	<0.01	640	80	20
Ratio								
Maximums/ minimums:	6.5	—	50	2.3	—	2.2	8.6	2.0

a. Golder (1987)

b. Minimum concentration for the period.

P = Value detected below reporting level.

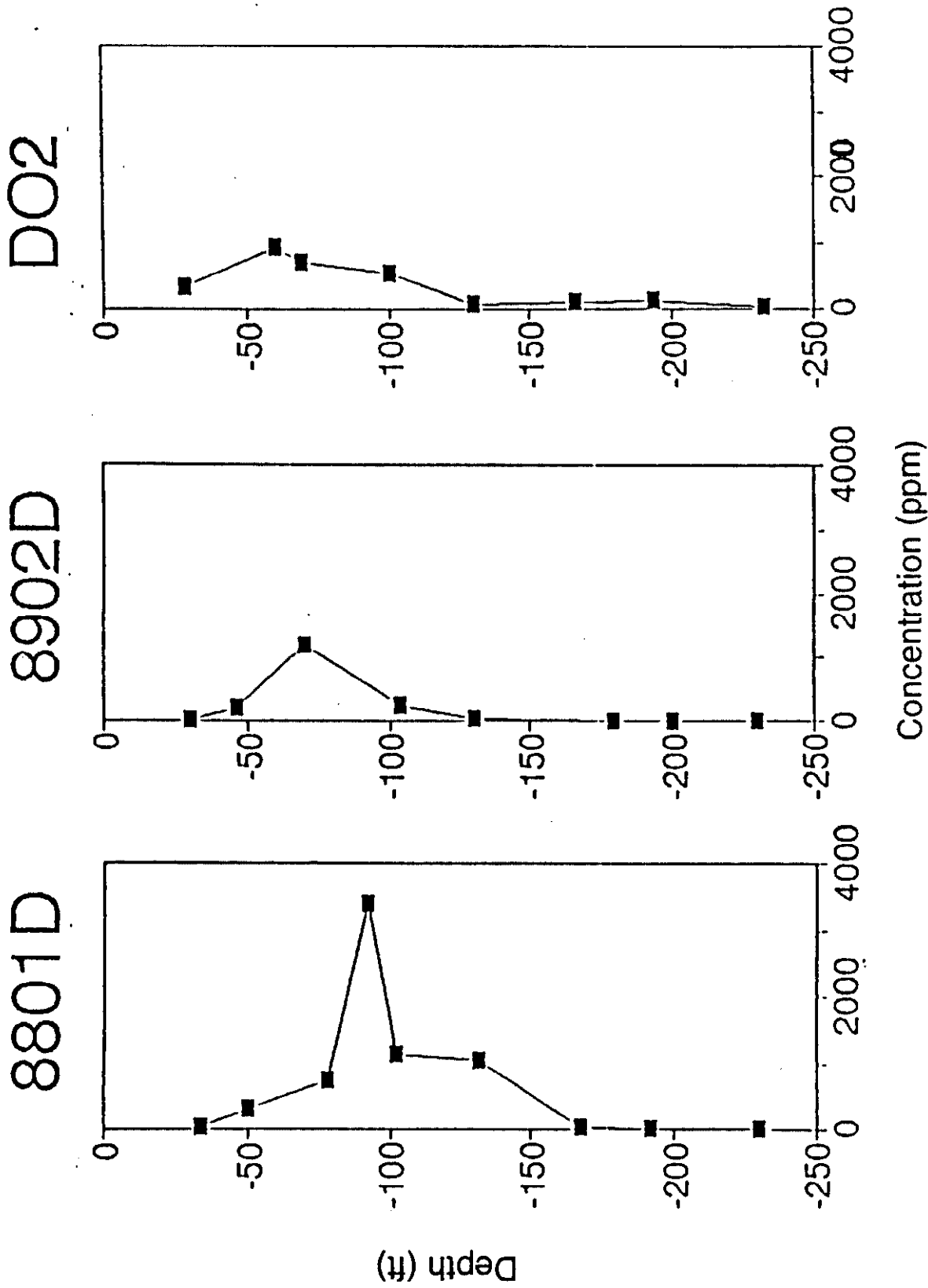
Gases have been extracted from existing gas sampling ports in Boreholes 8801D, 8902D, 78-4, WWW-1, 77-1, and DO2. Samples from the boreholes have been analyzed for organic contaminants to provide data on the composition of soil gas below the SDA. The average subsurface vapor concentrations during the four-month vapor vacuum extraction tests from multiple depths at three monitoring wells (8801, 8902, DO2) within the SDA are summarized in Figure 3-17, and discussed in detail by Sisson and Ellis (1991). Subsequent evaluation of these data revealed that they exhibit high variability, many outlier data points, and questionable reliability. Maximum concentration values reported from this time period are believed to have been significantly biased high because of a nonlinear response of the portable gas chromatograph (GC) a response unknown to the GC operators at that time. Data quality objectives and associated quality assurance requirements for vapor monitoring using the portable gas chromatograph were not well defined during this time period, and the relatively high concentration of vapors encountered were unique to gas chromatographic analysis where very low concentrations and associated instrument sensitivity is the norm. Therefore, the data set from the two-week and four-month test periods is useful only for qualitative identification of the vapor contaminants present, and only useful in semi-quantitative manner (e.g., relative measure, establishing trends, vertical profiles).

The reliability of vapor concentration data since April 1991 has been improved through (a) an enhanced sample collection procedure to ensure greater consistency during sample line purging and collection, (b) more comprehensive GC quality assurance procedures/samples, (c) improved GC calibration gas standards, (d) development and implementation of a sample dilution procedure, (e) additional GC operator training, (f) optimized GC maintenance, and (g) ongoing quality assurance review and evaluation of the data. Through these improvements, the subsurface vapor concentration data are more accurate, less variable, and more reliable (EDF, ERP-VVED-072). Figures 3-18 through 3-33 present subsurface vapor concentration data ( $\text{CCl}_4$ , TCE and  $\text{HCCl}_3$ ) obtained since these improvements to the GC operations have been implemented. The figures include concentrations from multiple depths at Wells 8801, 8902, DO2, 78-4, 77-1, and WWW-1. These data indicate a subsurface vapor plume very similar in makeup (primarily carbon tetrachloride and trichloroethylene) and similar in vertical concentration profile (highest concentration just above the 110 ft interbed) to the plume described by Sisson and Ellis (1991), in the 4-month VVE summary report. Additionally, the maximum vapor concentration values measured since the implementation of improved data collection procedures are notably lower and less variable than the maximum values reported in the summary report.

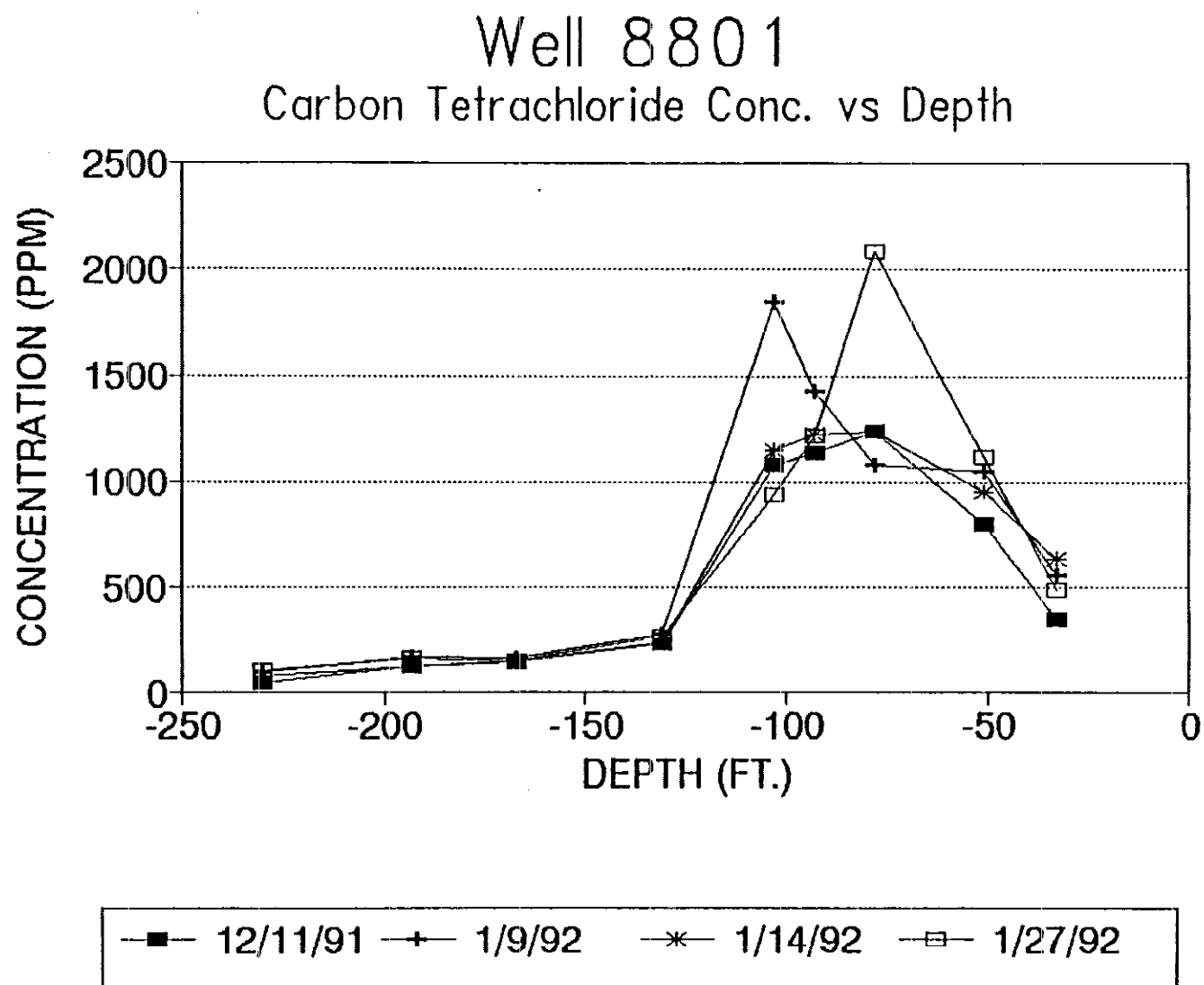
**3.3.3.2.3 Perched Water.** Perched groundwater at the SDA has only recently been analyzed for organic compounds. Well 92 is the only well from which multiple samples for organic constituents were available (Table 3-17) (Hubbell 1990).

One perched water sample collected during October 1987 from Well 92 reportedly contained the following:

- 1,200  $\mu\text{g/L}$  carbon tetrachloride
- 860  $\mu\text{g/L}$  trichloroethylene
- 650  $\mu\text{g/L}$  chloroform
- 140  $\mu\text{g/L}$  1,1,1-trichloroethane



**Figure 3-17.** Average concentration of carbon tetrachloride as function of depth in the monitoring wells (8801D, 8902D and D02) during the four-month VVE test in April through August 1990 (Sisson et al. 1991).



**Figure 3-18.** Concentration of Carbon Tetrachloride as a function of depth in monitoring well 8801D.

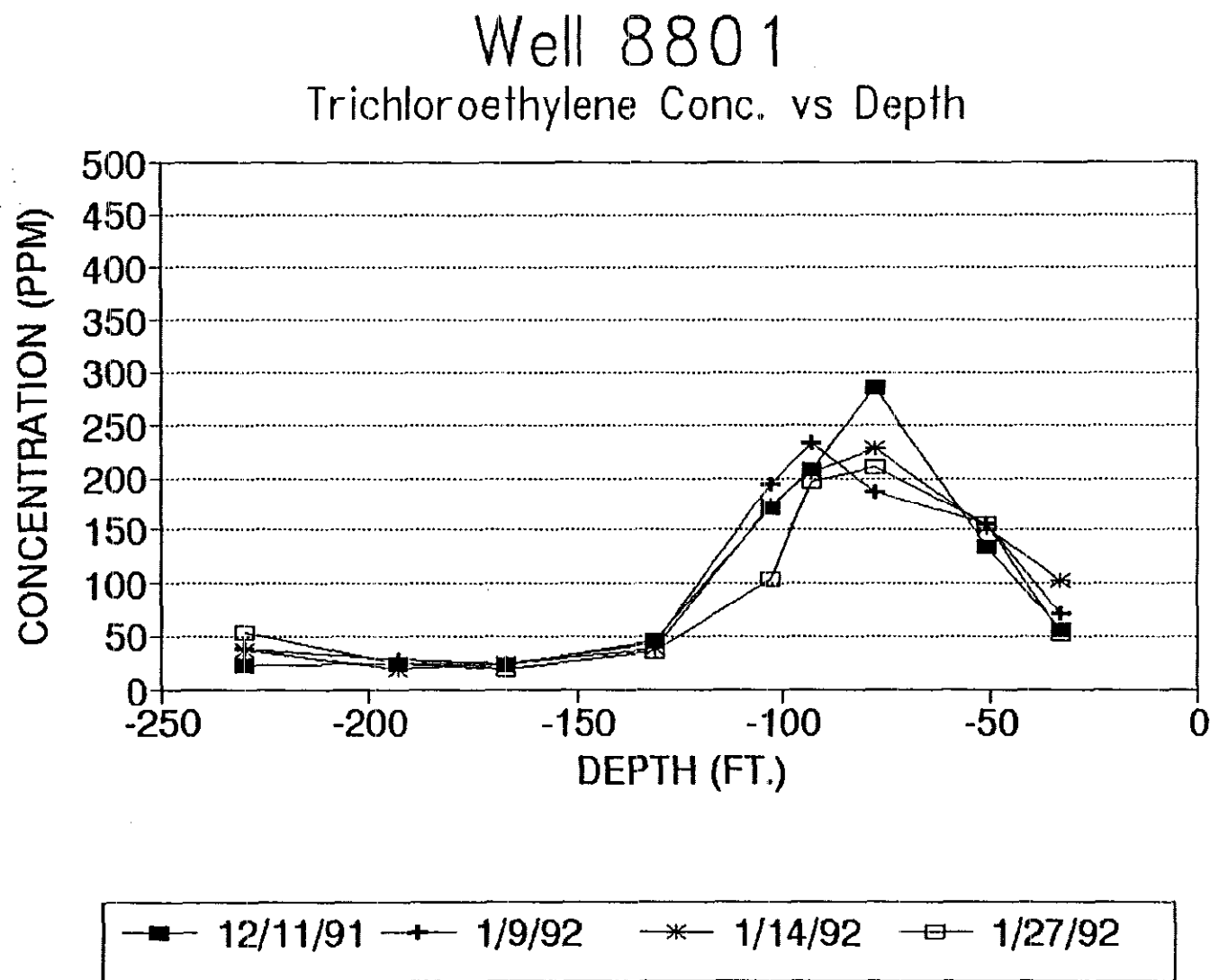


Figure 3-19. Concentration of Trichloroethylene as a function of depth in monitoring well 8801D.

# Well 8801

## Chloroform Conc. vs Depth

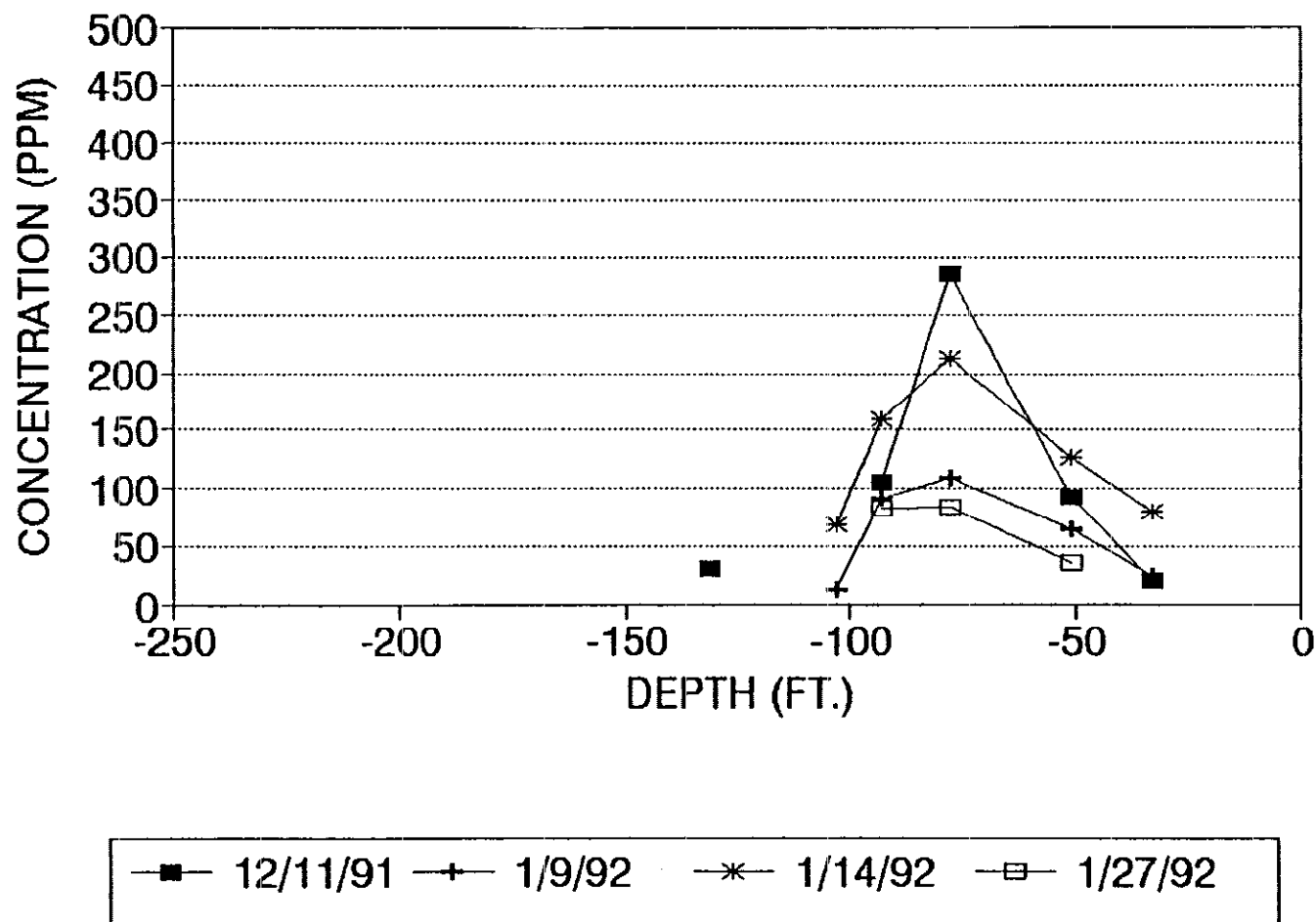


Figure 3-20. Concentration of Chloroform as a function of depth in monitoring well 8801D.

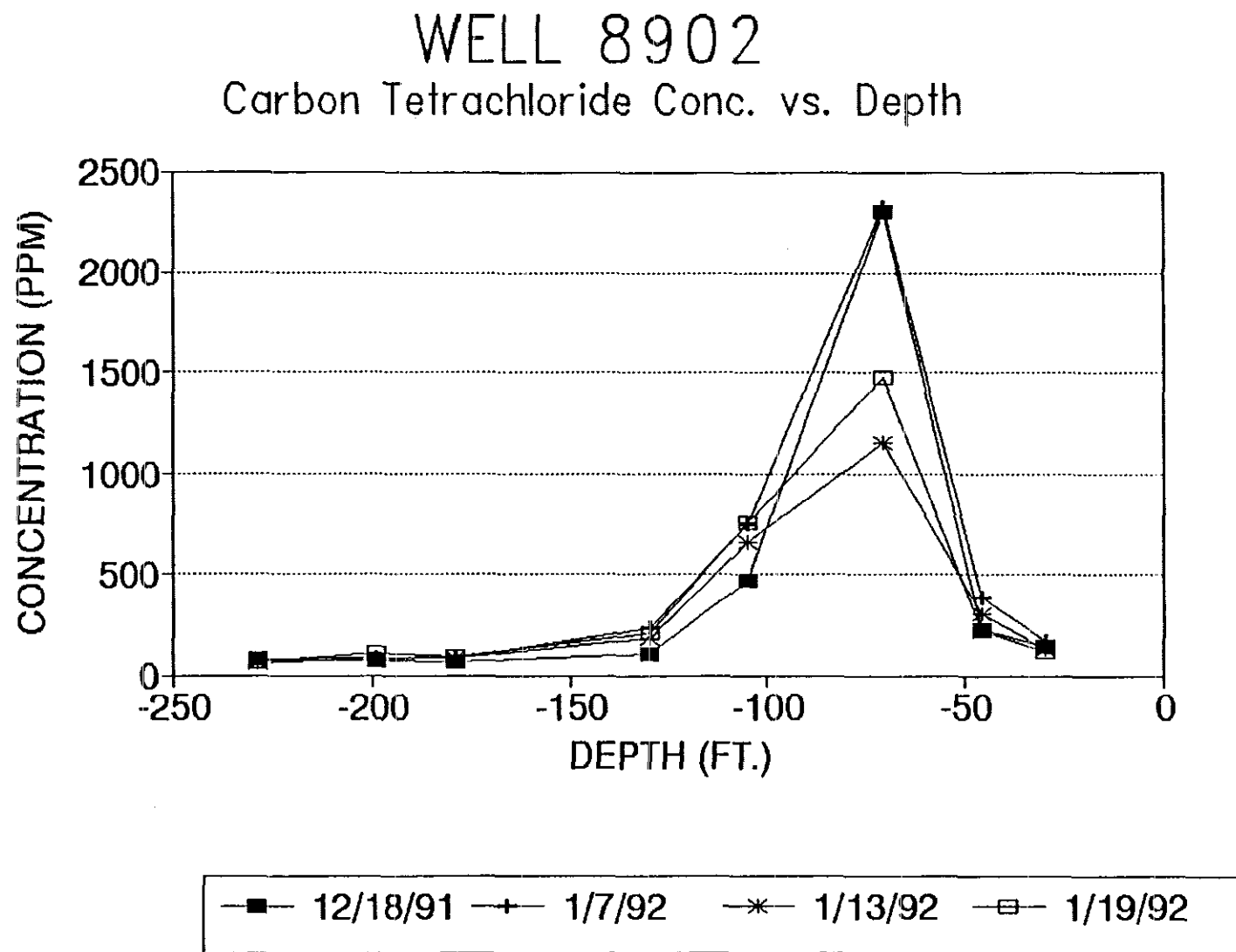


Figure 3-21. Concentration of Carbon Tetrachloride as a function of depth in monitoring well 8902D.

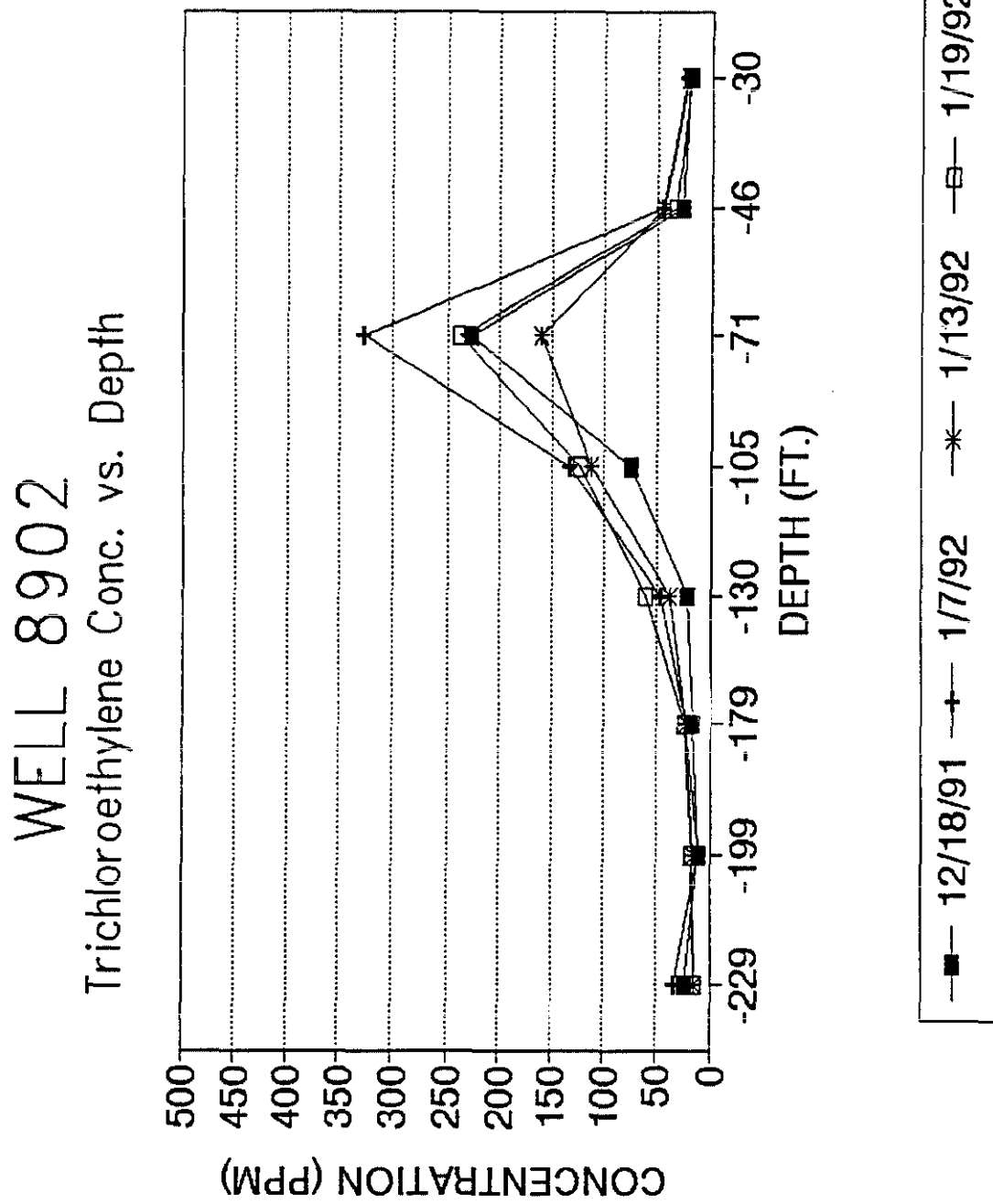


Figure 3-22. Concentration of Trichloroethylene as a function of depth in monitoring well 8902D.



# WELL 8902

## Chloroform Conc. vs. Depth

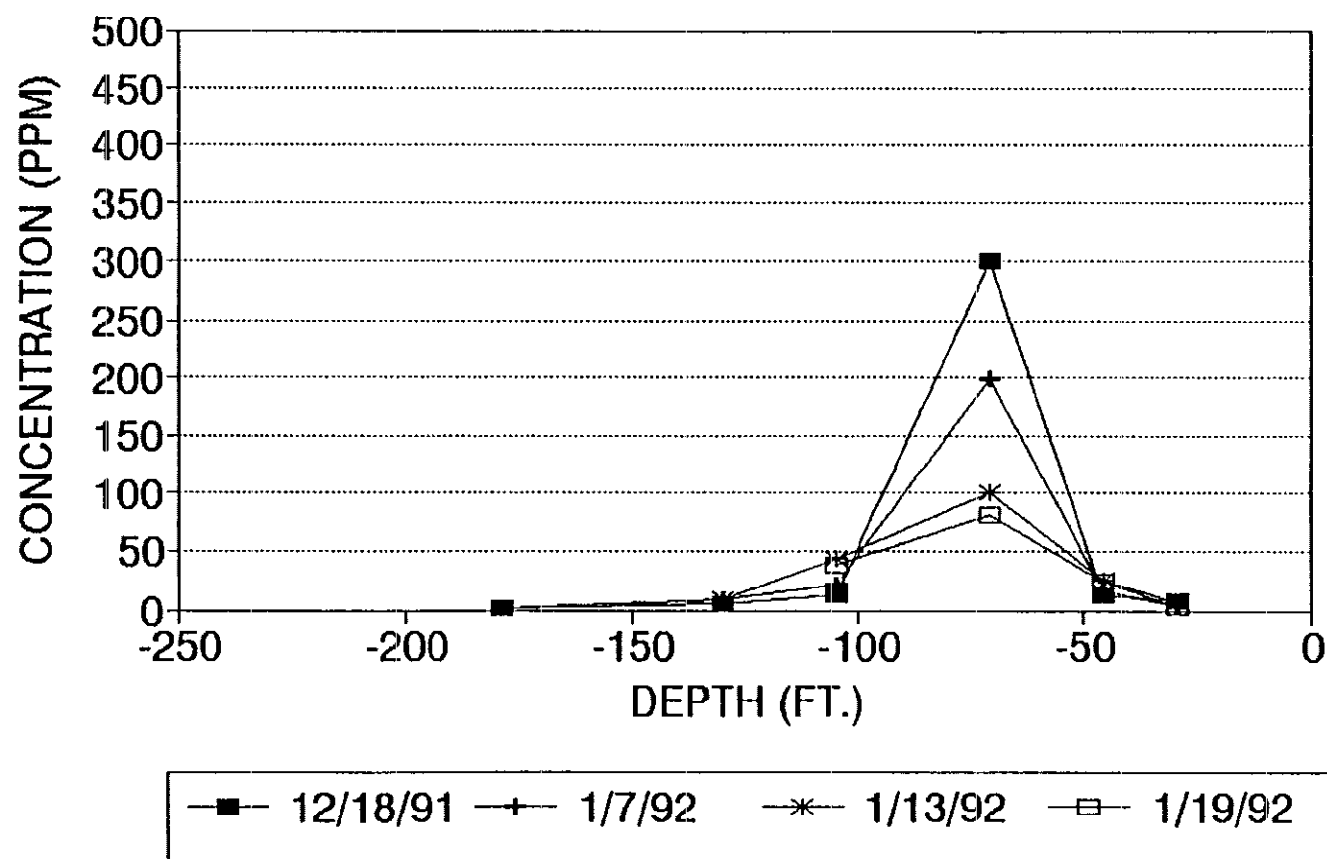
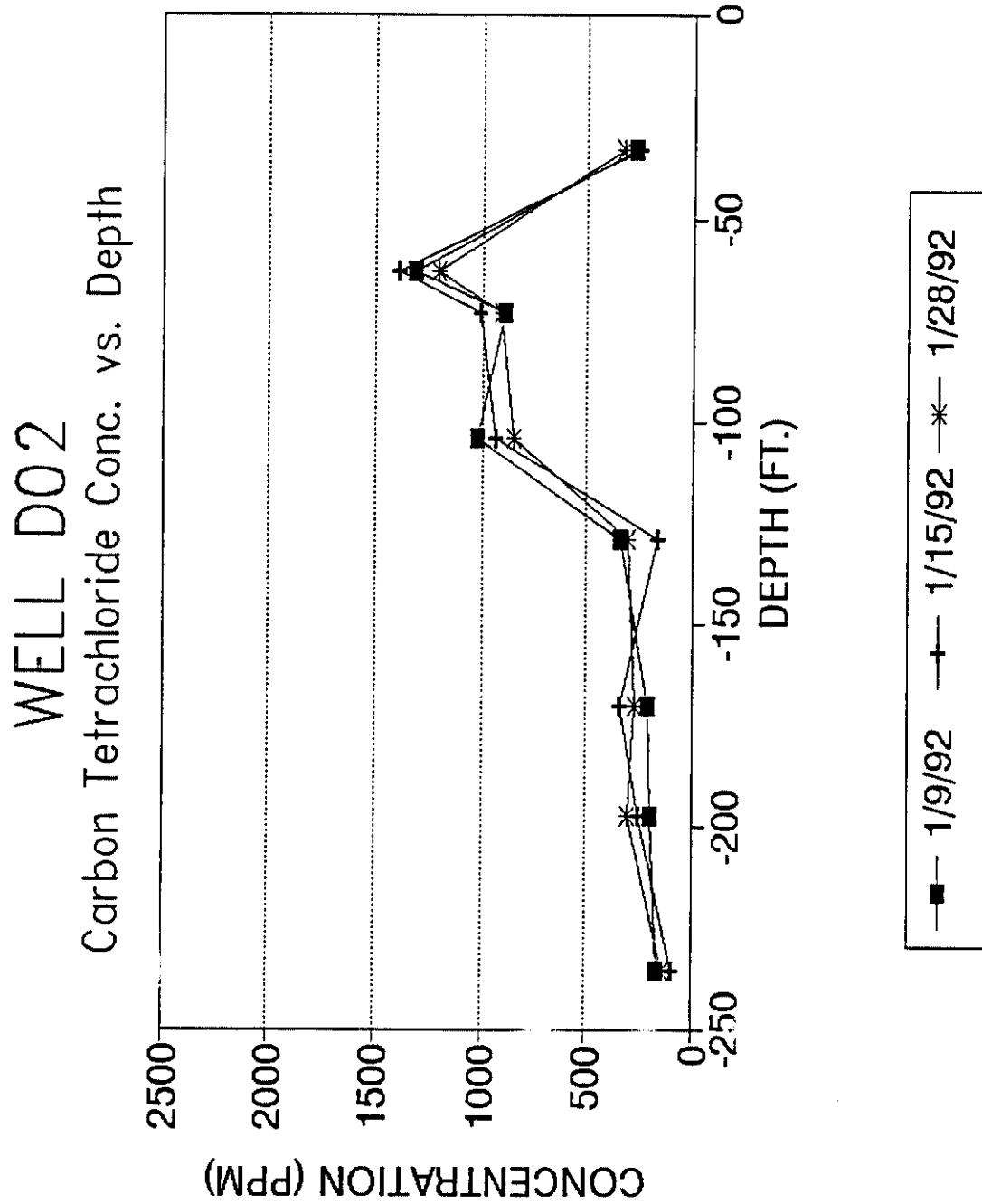


Figure 3-23. Concentration of Chloroform as a function of depth in monitoring well 8902D.



**Figure 3-24.** Concentration of Carbon Tetrachloride as a function of depth in monitoring well D02.

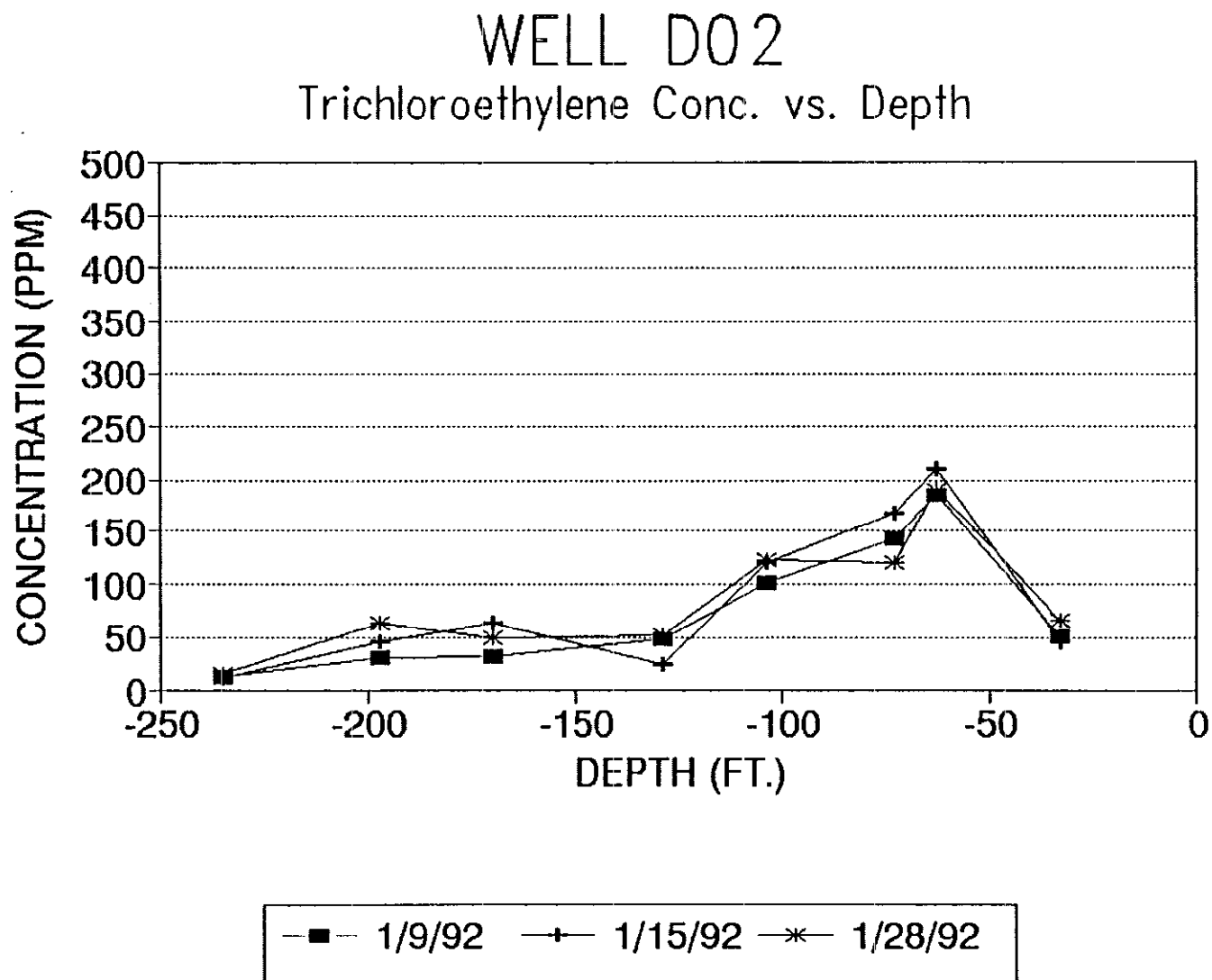
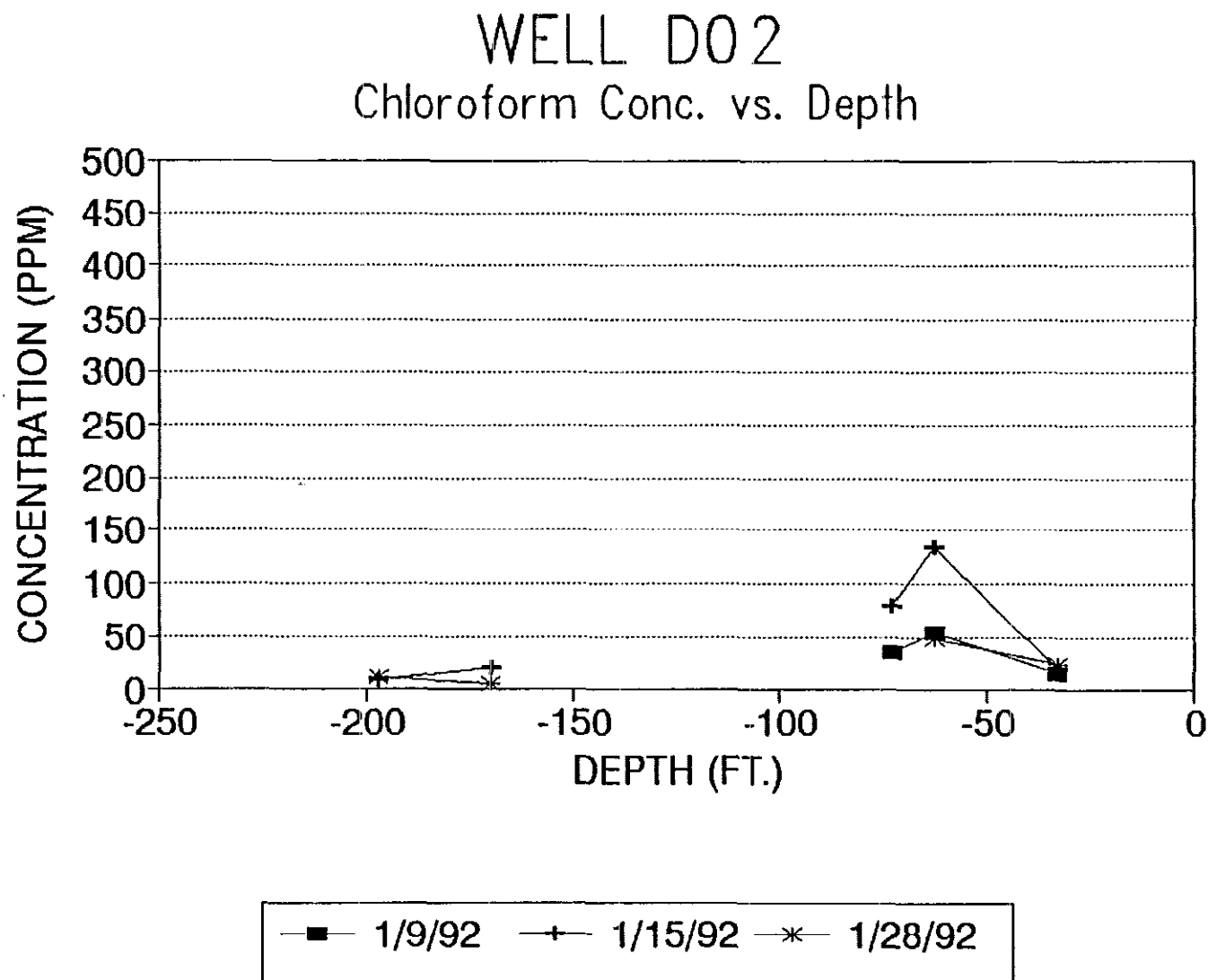


Figure 3-25. Concentration of Trichloroethylene as a function of depth in monitoring well D02.



**Figure 3-26.** Concentration of Chloroform as a function of depth in monitoring well D02.

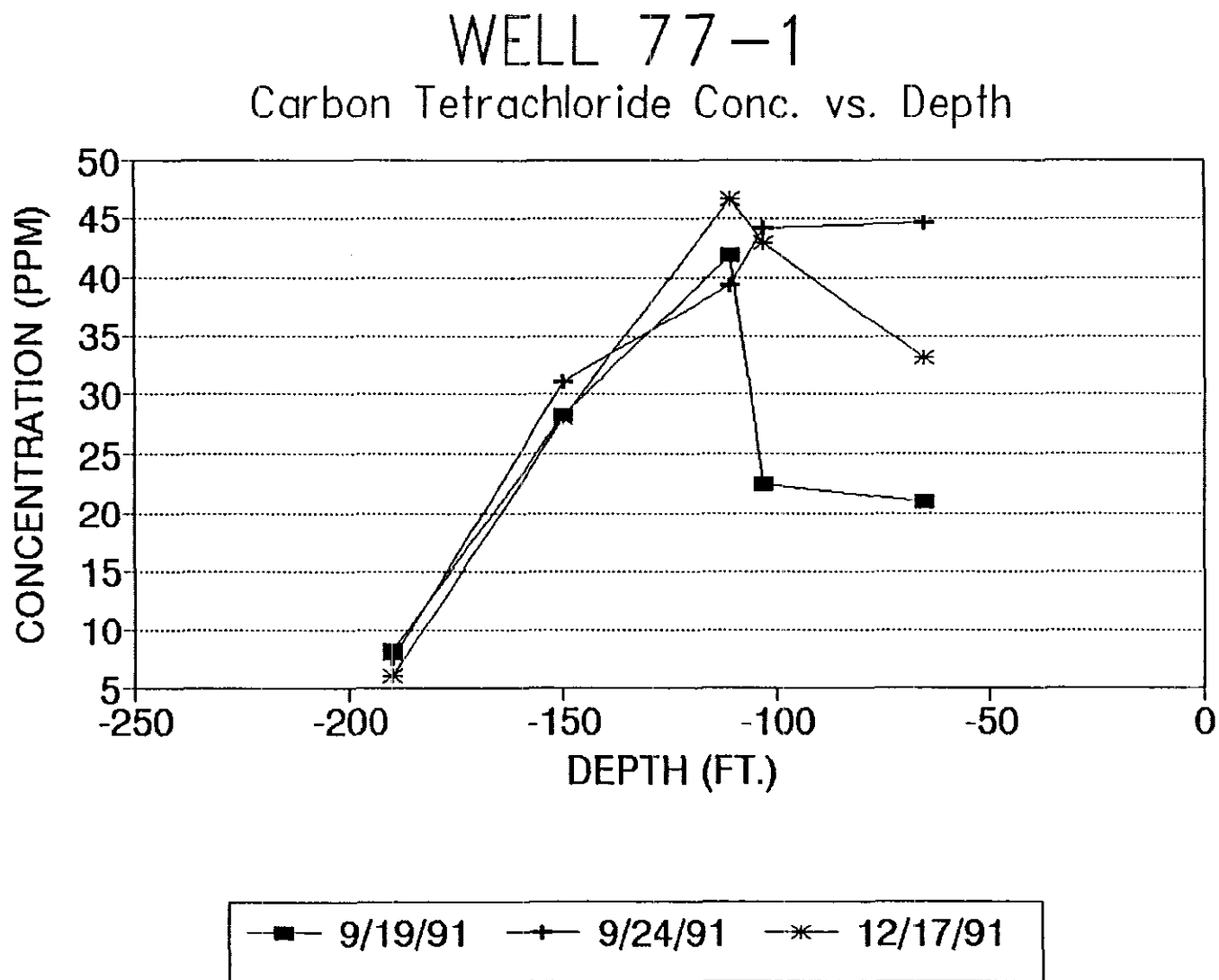
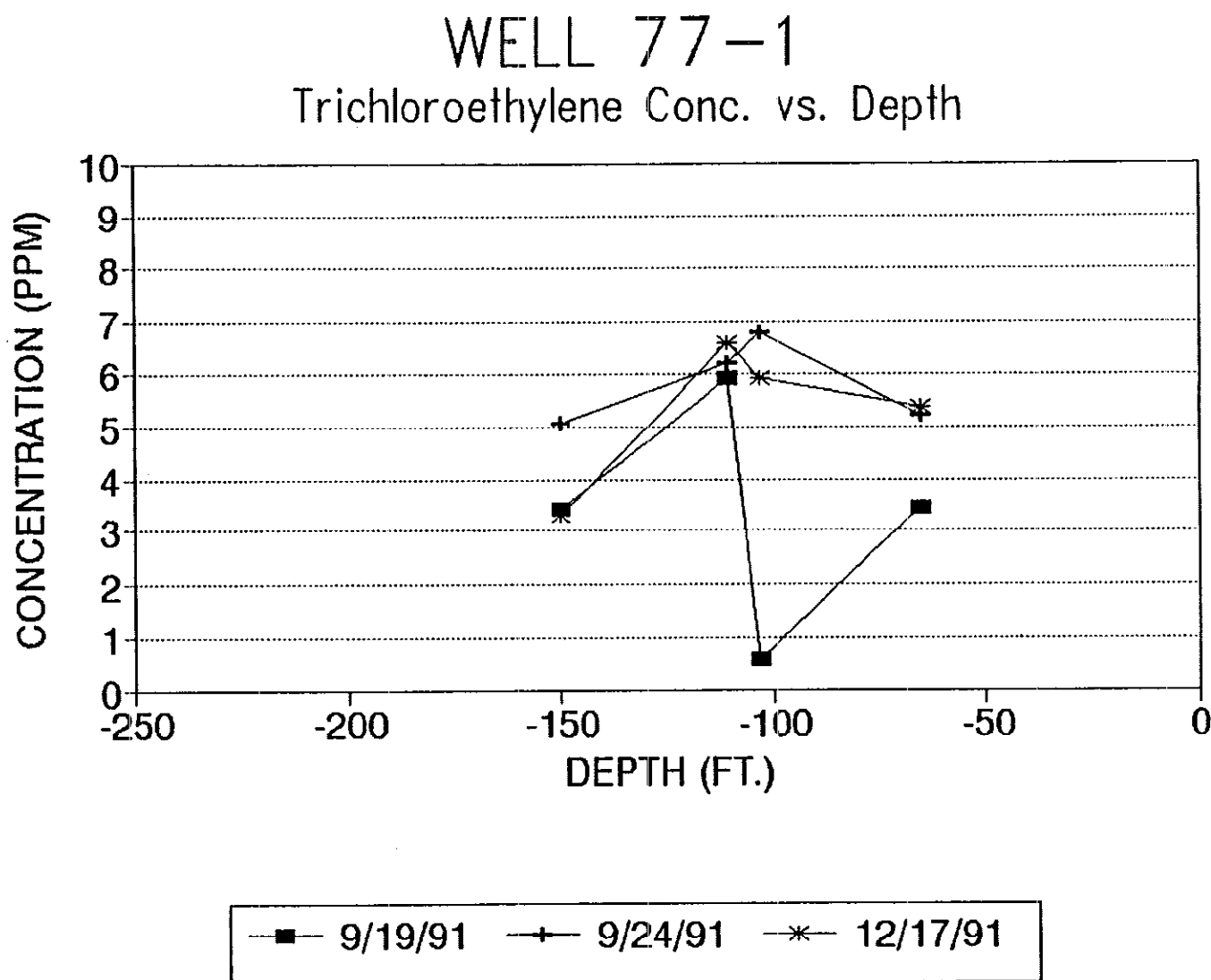


Figure 3-27. Concentration of Carbon Tetrachloride as a function of depth in monitoring well 77-1.



**Figure 3-28.** Concentration of Trichloroethylene as a function of depth in monitoring well 77-1.

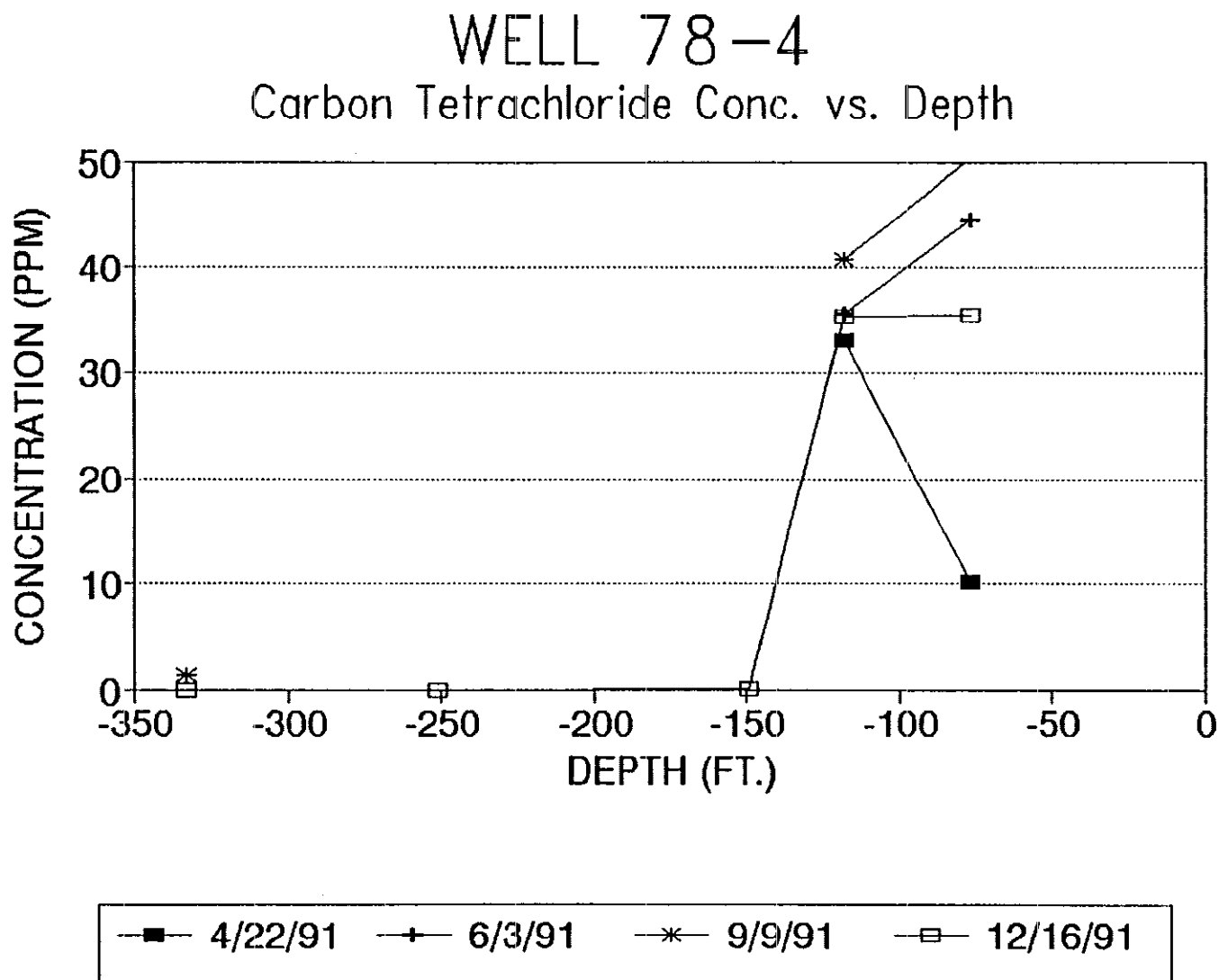
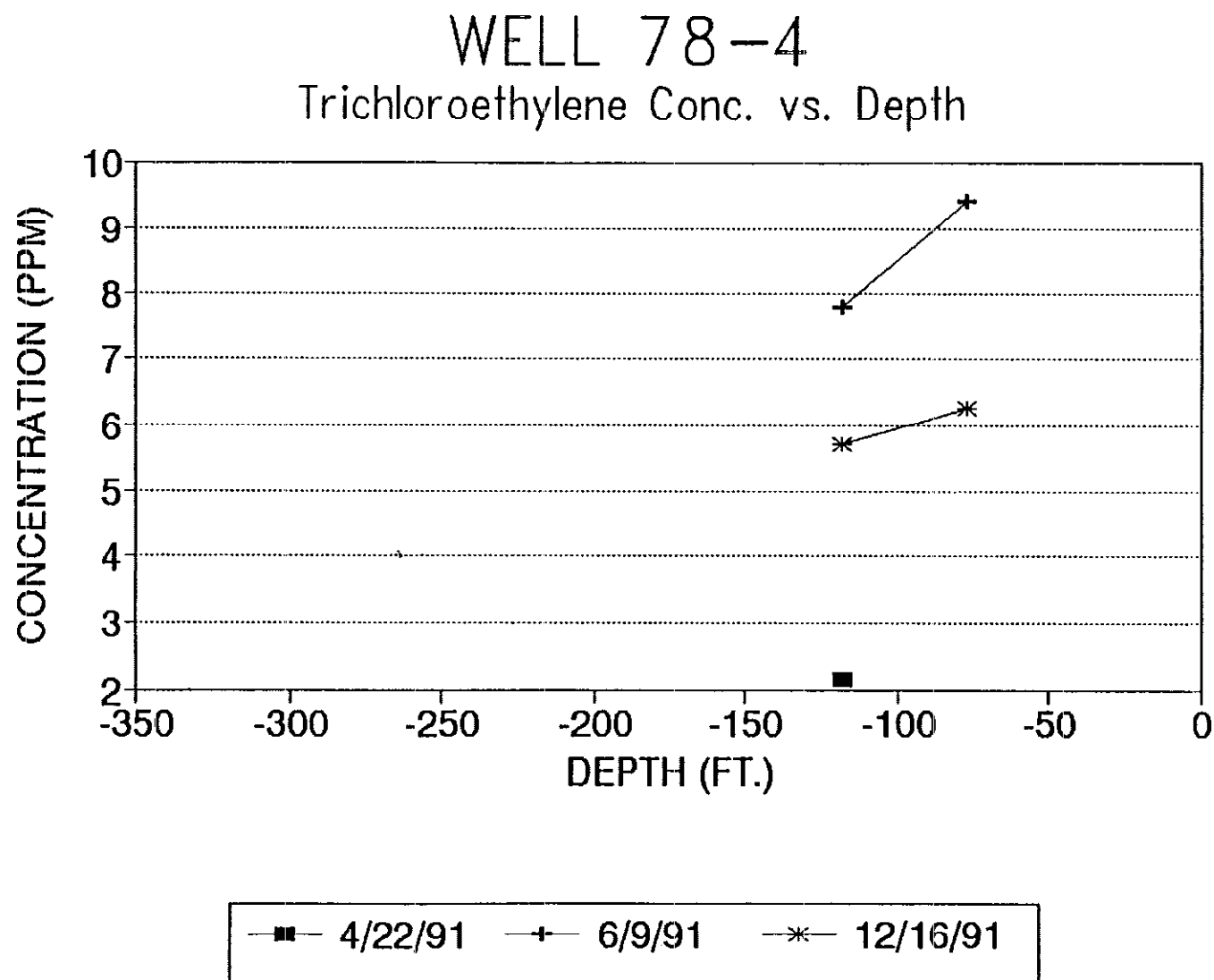
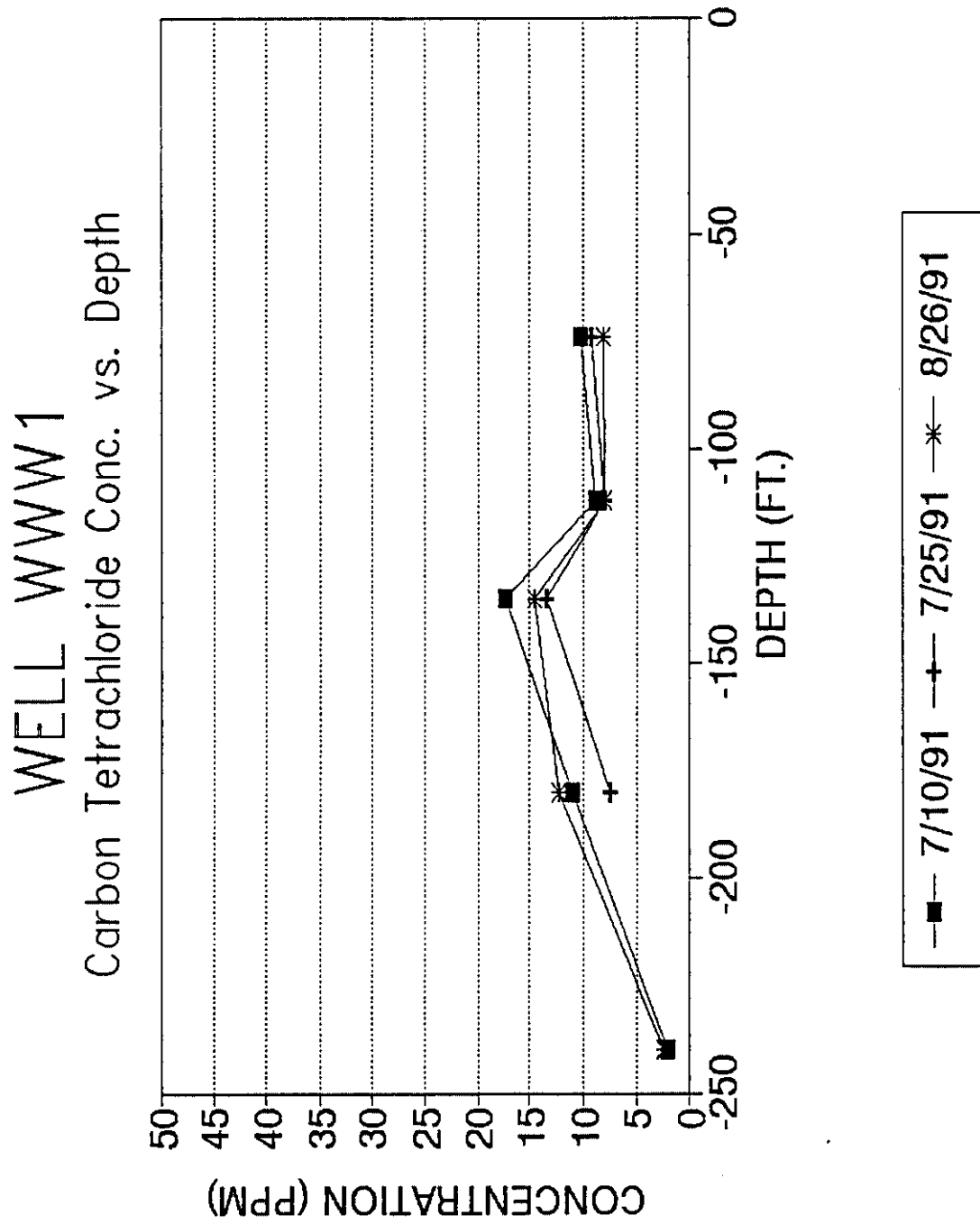


Figure 3-29. Concentration of Carbon Tetrachloride as a function of depth in monitoring well 78-4.

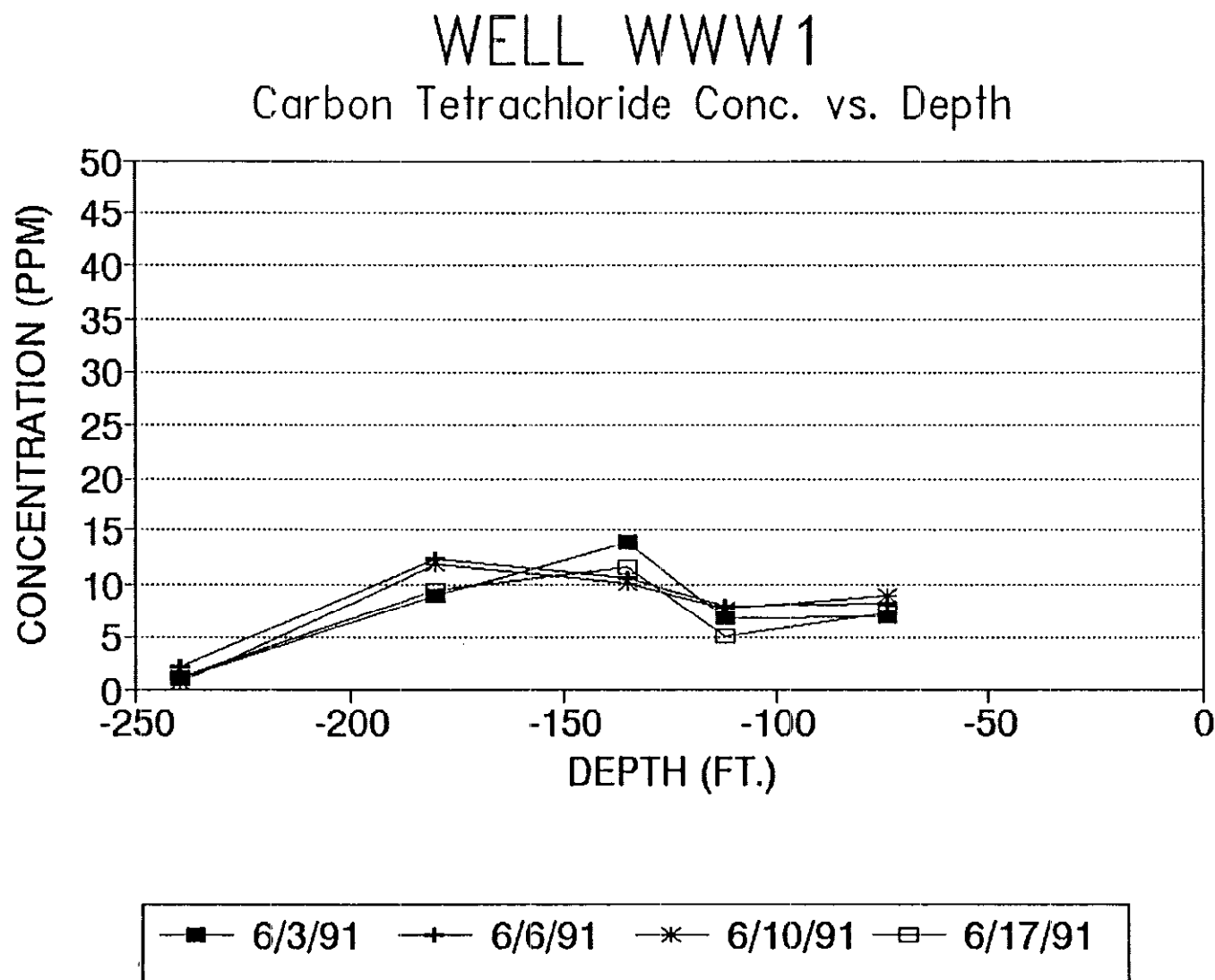


**Figure 3-30.** Concentration of Trichloroethylene as a function of depth in monitoring well 78-4.



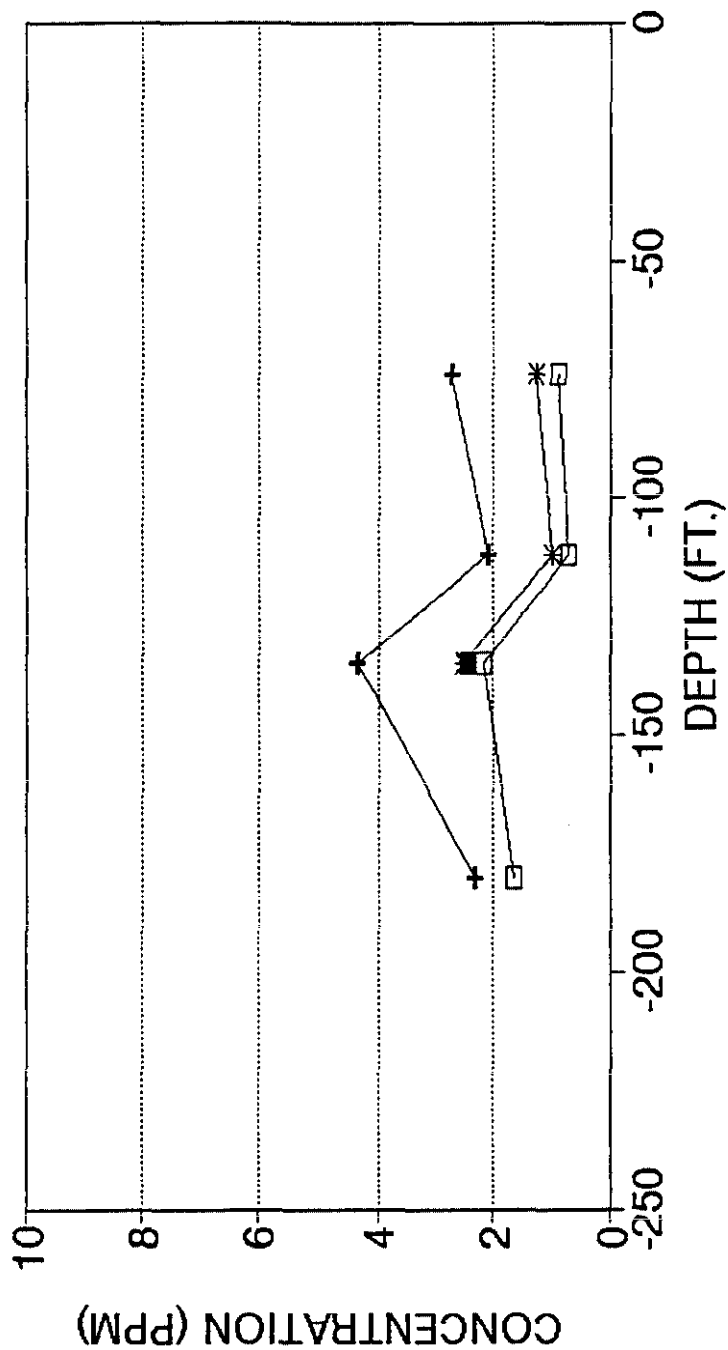


**Figure 3-31.** Concentration of Carbon Tetrachloride as a function of depth in monitoring well WWW-1.



**Figure 3-32.** Concentration of Carbon Tetrachloride as a function of depth in monitoring well WWW-1.

# WELL WWW1 Trichloroethylene Conc. vs. Depth



6/17/91
  7/10/91
  7/25/91
  8/26/91

FIGURE 3-33. Concentration of Trichloroethylene as a function of depth in monitoring well WWW-1.

- 110 µg/L tetrachloroethylene
- 13 µg/L 1,1-dichloroethane
- 5.9 µg/L 1,2-dichloropropane
- 1.0 µg/L 1,1,2,2-tetrachloroethane
- 0.8 µg/L 1,1-dichloroethylene.

Tichlorodifluoromethane and toluene were not detected above the reporting level of 0.2 µg/L (Laney et al. 1988). A subsequent sample in April 1988 detected the same analytes plus dichlorodifluoromethane and toluene without 1,1,2,2-tetrachloroethane and 1,2-dichloropropane (Hubbell 1990). All detected contaminants were reported at somewhat higher levels in the later sample (Table 3-18). It is not known if this reflects an actual contaminant concentration increase or if it reflects sampling and/or analytical variability. The VOC contamination in the perched water was approximately the equilibrium value as defined by the Henry's law constant in a nearby vapor monitoring port (Hubbell 1990).

**3.3.3.3 Other Investigations.** Other investigations of the vadose zone media have been or are being conducted at the SDA. These include invasive and noninvasive studies to characterize potential sources of contamination and migration pathways and processes. The studies include downhole and surface geophysics, and soil physical parameter measurement.

**3.3.3.3.1 Geophysical Investigations.** In addition to the ongoing geological, hydrogeological, and chemical studies being performed at the SDA, several geophysical techniques have been employed to enhance the understanding of the vadose zone at the RWMC. Downhole geophysics were performed on most of the boreholes drilled at the RWMC. Three surface geophysical investigations have also been conducted at the RWMC to characterize waste pit configurations, and depths to various geologic units.

The downhole geophysical techniques varied from borehole to borehole. However, the most frequently used techniques were gamma, gamma-gamma, and neutron logs. The downhole geophysical data were used to characterize vertical changes in stratigraphy, porosity (relative water content), and density.

The first of the surface geophysical investigations was a seismic reflection study conducted in 1988 by Kansas Geological Survey personnel. The seismic survey was designed to detect a 10- to 13-ft (3- to 4-m) thick sedimentary layer which underlies much of the area at a depth of 98 ft (30 m). The results of the survey suggested the 110-ft interbed was detected but absolute depth measurement and thickness were impossible to calculate with the data.

In 1989, UNC Geotech completed a series of surveys using total magnetic field, magnetic gradient, electromagnetic conductivity, induction electromagnetic inphase, very low frequency electromagnetic, and seismic refraction techniques. These geophysical surveys were conducted at the Cold Pit (Test Pit), Acid Pit, and Pit 9 at the RWMC to define pit boundaries and identify buried

tanks and debris. Of the techniques used, total magnetic field, magnetic gradient, electromagnetic conductivity, and electromagnetic inphase yielded the best results. At the Cold Pit, the geophysically determined pit boundaries were generally within one meter of the historical boundaries. The geophysical studies conducted at the Acid Pit indicated that the pit was smaller than the size reported in the literature. The geophysics also suggested that acid may have migrated beneath the original base of the pit. At Pit 9, the pit boundary was estimated to be approximately 6.5 ft beyond the historical boundary. Seismic data could not be used to determine the geometry of Pit 9 due to interference caused by an approximately 3-ft thick frozen surface layer present at the time of the survey.

A third surface geophysical study was conducted by Ebasco Services, Inc., in 1989. Ebasco conducted a seismic refraction survey at Pit 9 and the Acid Pit to determine the depth to bedrock. Five seismic lines were run at each pit. Depths to bedrock ranged from 15 to 21 ft under the Acid Pit and from 10 to 18 ft at Pit 9. While the depth to bedrock is 15 to 21 ft under the Acid Pit and 10 to 18 ft at Pit 9, the actual thickness of the sedimentary material between the bedrock and waste is known to be variable.

**3.3.3.3.2 Moisture Flux Investigations.** This study uses in situ field equipment to measure and monitor soil-water content to

- Determine the volume and rate of moisture inflow through the SDA surface
- Identify pathways of moisture migration
- Characterize the effect of lithologic interfaces on moisture movement
- Develop data describing moisture movement through the unsaturated zone for verification of a simulation model.

These data will be used to field calibrate a model to predict long-term migration of volatile organics in the unsaturated zone.

Instrumentation installed for the RWMC subsurface investigations program includes 59 psychrometers, 98 heat dissipation sensors, 50 gypsum blocks, 19 tensiometers, 39 porous cup lysimeters, and 2 neutron access tubes. Data from these instruments (except lysimeters) are collected monthly. Lysimeters also provide points from which to collect samples of soil water for contaminant and chemical parameter analysis. Data analysis from this program is not complete and is an ongoing task (Laney et al. 1988 and McElroy and Hubbell 1989).

### **3.3.4 Occupational Exposure Surveys**

A review of existing data on contaminant exposure levels to SDA worker populations was conducted to determine whether these levels were in compliance with Occupational Safety and Health Administration (OSHA) promulgated occupational standards as well as recommended standards of the American Conference of Governmental Industrial Hygienists. Because the INEL is relatively isolated from any developed areas, only individuals employed at the site were considered

potentially exposed to site contaminants. Approximately 99 workers are actively employed at the RWMC and the SDA where they are engaged primarily in light to heavy industry involved in the disposal of hazardous wastes.

To estimate the volatile organic contaminant exposure levels for site workers, limited population surveys were performed at the SDA by monitoring air contaminant concentrations during drilling activities at Boreholes 8901, 8902, and DO2 in 1989. Monitoring was conducted using passive dosimeter vapor badges. Although passive dosimeter badges are subject to interference from other compounds and are not considered to be the most precise sampling available, they do offer a simple, economical screen to determine approximate cumulative 8-hour exposure levels. All samples were obtained from worker breathing zones. Exposure evaluations were performed for organic vapors.

**3.3.4.1 Organic Vapor Monitoring.** Organic vapor exposures were monitored using 3M organic vapor badges. Exposure levels were quantified for five organic compounds: carbon tetrachloride, methylene chloride, tetrachloroethylene, 1,1,1-trichloroethane, and trichloroethylene. As shown in Table 3-22, carbon tetrachloride was detected in the greatest number of samples (14/107) and was found at the highest concentration (maximum = 2.30 ppm) for all organics. This maximum value slightly exceeds the recently promulgated OSHA 8-hour, time-weighted-average permissible exposure limit of 2 ppm. Two other carbon tetrachloride detections (2.17 and 2.1 ppm) were also above the current standard. The maximum value for carbon tetrachloride (2.30 ppm) is within the acceptable range of sampling variability for a 2 ppm standard. At the time the samples were taken, these detections were below the OSHA standard in effect (10 ppm). The American Conference of Governmental Industrial Hygienists threshold limit value is 5 ppm, well above the maximum observed concentration. All other VOCs measured were two to three orders of magnitude below their respective OSHA permissible exposure limits. One of the VOCs detected was methylene chloride, which is a degradation product of chloroform. Methylene chloride has not been found in other media. However, it is a standard industrial solvent used in cleaning and degreasing. The ubiquitous nature of these solvents makes an accurate determination of their source difficult. From these data, it would appear SDA workers are not excessively exposed to site VOCs and conditions do not pose an imminent health threat.

**3.3.4.2 Conclusions.** The human population data presented in this section are limited to the drilling operations of three boreholes. Thus, these results can only be considered preliminary. In some instances the sampling was conducted within the borehole rather than the worker breathing zone. Even so, much of the available data were reported to be below analytical detection limits. Based on the data presented for organic compounds, there appear to be no excessive or dangerous occupational exposures during the drilling of these boreholes.

### **3.4 Identification of Potentially Applicable or Relevant and Appropriate Requirements**

The Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 requires the selection of remedial actions at Superfund hazardous waste sites that are protective of human health and the environment, cost-effective, and technologically and administratively feasible. Section 121 of CERCLA specifies that response action must be undertaken in compliance with applicable or relevant and appropriate requirements (ARARs) established in Federal and state environmental laws.

**Table 3-22.** Summary of human population monitoring data.

Organic chemicals	Number of detections	Frequency of Detection		PEL <sup>a</sup> (ppm)	TLV <sup>b</sup> (ppm)
		Number of badges analyzed	Concentration range (ppm)		
<u>Organics</u>					
Carbon tetrachloride	14	107	<0.24-2.30	2	8
Methylene chloride	3	37	0.10-0.38	500	50
Tetrachloroethylene	1	88	0.14	25	50
1,1,1-Trichloroethane	2	67	<0.64	350	250
Trichloroethylene	2	89	0.12-0.14	50	50

a. Permissible exposure limit.

b. Threshold limit value set by American Conference of Government Industrial Hygienists.

The revised National Contingency Plan, 40 CFR 300, published at 55 FR 8813 clearly states that compliance with ARARs is one of the statutory requirements for remedy selection. Prior to the CERCLA amendments of 1986, the EPA required compliance with all Federal ARARs, but only consideration of state criteria and standards. The revised National Contingency Plan incorporates the new statutory requirement that in addition to Federal ARARs, remedies must address state environmental requirements and facility siting laws that are more stringent than corresponding Federal standards. In addition, the importance of nonpromulgated criteria, or other advisory information "to be considered," is formally recognized in the National Contingency Plan in the development of remediation goals or cleanup levels.

In the interim guidance published by EPA on compliance with ARARs (52 FR 32496-32499), and the more recently published guidance document *CERCLA Compliance with Other Laws Manual* (EPA 1988a), several different types of requirements are identified with which CERCLA remedial actions must comply: ambient or chemical-specific requirements, location-specific requirements, and action-specific requirements.

Because situations at CERCLA sites vary widely, EPA cannot categorically specify requirements that will be ARARs for every site. ARARs can only be identified on a site-specific basis (i.e., established in connection with the characteristics of the particular site, the chemicals present at the site, and the remedial action alternatives suggested by the circumstances of the site).

EPA has specified that the different ARARs that may apply to a site and its remediation should be identified and considered at several points in the remediation planning process (52 FR 32496), as delineated below:

- During scoping of the RI/FS, chemical- and location-specific ARARs may be identified on a preliminary basis
- During the site characterization phase of the RI when the baseline public health evaluation is conducted to assess risk at a given site, the chemical-specific ARARs and advisories and location-specific ARARs are identified more comprehensively and used to help determine preliminary cleanup objectives.

### **3.4.1 Chemical-Specific ARARs**

This section identifies a preliminary set of chemical-specific ARARs that may apply to remedial actions for the vadose zone located beneath the SDA. Section 3.4.1.1 provides an overview of the role of chemical specific ARARs in the FS process and associated risk assessments. Section 3.4.1.2 summarizes a preliminary list of chemical-specific ARARs for VOCs present at the SDA.

**3.4.1.1 Use of Chemical-Specific ARARs in the Feasibility Study Process.** The screening and detailed analysis of remedial action alternatives must consider effectiveness, implementability, and cost. Within the context of the effectiveness evaluation, chemical-specific ARARs assume major significance as each alternative is evaluated with regard to its effectiveness in protecting human health and the environment.

The ability to protect human health and the environment is the primary requirement that CERCLA remedial actions must meet (55 FR 8813). EPA considers a remedy protective if it "adequately eliminates, reduces, or controls all current and potential risks posed through each [exposure] pathway [at] the site." In accomplishing this, a given remediation alternative must meet or exceed ARARs or other risk-based levels established through a risk assessment when ARARs do not exist or are waived.

In the revised National Contingency Plan (55 FR 8813) and in the recently published draft guidance manual *CERCLA Compliance with Other Laws* (EPA 1988a), EPA specifies that when ARARs are not available for a given chemical, or where such chemical-specific ARARs are not sufficient to be protective, health advisory levels should be identified or developed to ensure that a remedy is protective. Carcinogenic and noncarcinogenic effects are both considered in determining ARARs and evaluating protectiveness. For carcinogenic effects, the health advisory or risk-based levels are selected such that the total lifetime risk to the exposed population of all contaminants falls within the acceptable range of  $10^{-4}$  to  $10^{-6}$ . The  $10^{-6}$  risk level is specified by EPA as a point of departure for determining remediation goals. For noncarcinogenic effects, cleanup levels should be based on acceptable levels of exposure as determined by the EPA reference doses, taking into account the effects of other contaminants at the site.

Therefore, chemical-specific ARARs serve two primary uses: (1) to identify requirements that must be met as a minimum by a selected remedial action alternative (unless a waiver is obtained), and (2) to provide a basis for establishing appropriate cleanup levels. The public health risk assessment of a given remedial action alternative characterizes the actual risk of exposure of human receptors to contaminants under investigation.



For carcinogenic effects, risk characterization yields a probabilistic estimate of the additional lifetime risk of cancer in the exposed individual, or the incidence of new cases of cancer in populations. For noncarcinogenic effects, as noted above, exposure levels or doses for all subject compounds are evaluated to determine levels or doses if these exceed EPA reference doses. When a chemical-specific ARAR is available for all subject compounds of concern and the chemical-specific ARARs are determined to be protective, these requirements become the chemical-specific cleanup goals. However, as noted above, when ARARs are found not to be protective or are not available, the results of the risk assessment (i.e., health advisory levels) are used to establish the more stringent target cleanup goals. The requirement that a remedial action alternative meet chemical-specific ARARs does not ensure that the proposed alternative is protective, and thereby acceptable. Additional criteria for evaluating acceptability include

- Evaluating the combined carcinogenic risk associated with the ARAR limits for all chemicals at a given site (assuming additivity of effect in the absence of data on synergism or antagonism)
- Establishing that ARARs do not exceed EPA reference doses for noncarcinogenic effects, and are sufficiently protective when multiple chemicals are present
- Determining whether environmental effects (in addition to human health considerations) are adequately addressed by the ARARs
- Evaluating whether the chemical-specific ARARs adequately cover all significant pathways of human exposure identified in a baseline risk assessment.

The EPA *Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual* (EPA 1989a) provides guidance on evaluating multiple exposure to chemicals (both carcinogenic and noncarcinogenic effects), and on establishing acceptable exposure levels when no chemical-specific ARARs exist.

**3.4.1.2 Identification of Chemical-Specific ARARs for Volatile Organic Compounds at the SDA.** Table 3-23 is a list of available Federal and Idaho chemical-specific ARARs for organic compounds identified at the SDA. The compounds listed in Table 3-23 have been identified based on the constituents identified in the wastes and the compounds detected in various environmental media. Provided in Table 3-23 is a list of (a) EPA primary drinking water standards, (b) EPA drinking water MCL goals, (c) Federal ambient water quality criteria for the protection of human health for consumption of aquatic organisms and water adjusted for drinking water only, and (d) Idaho State drinking water standards.

Given the exposure pathways of concern at the SDA identified in Section 2 (soil, air, and groundwater), the chemical-specific ARARs of primary importance are the Federal and Idaho water quality criteria and standards. These are briefly discussed below. Note that neither Federal nor Idaho ARARs are available for soil.

MCLs are enforceable EPA standards and represent the allowable lifetime exposure to a contaminant in public drinking water supplies. The MCLs are established, taking into consideration potential health effects and incorporating a safety factor to provide adequate protection for sensitive subpopulations. In establishing MCLs, EPA also considers the feasibility of attaining such a concentration given the best available technology, treatment techniques, and cost.

**T 3-23. Potential ARARs for contaminants identified at the**

Organic compound	Federal Drinking Water Regulations		Federal Ambient Water Quality Criteria		Idaho State Water Quality Standards
	Primary drinking water standards (MCLs)(mg/L)	Drinking water maximum contaminant level goals (mg/L)	Human health: adjusted for drinking water only (mg/L)	Human health: consumption of water & aquatic organisms (mg/L)	
1,1,2,2-Tetrachloroethane					
Tetrachloroethylene		0	(.00088)	(.0008)	
Toluene		2	15	14.3	1.0
1,1,1-Trichloroethane	0.2		19	18.4	0.2
Trichlorotrifluoroethane					
Trichloroethylene	0.005	0	(.0028)	(.0027)	0.005
Acetone					
Carbon Tetrachloride	0.005	0	(.00042)	(.0004)	0.005
Chloroform	0.1		(.00019)	(.00019)	
Dichlorodifluoromethane					
1,1-Dichloroethane					
1,1-Dichloroethylene	0.007	0.007	(.000033)	(.000033)	0.007
1,2-Dichloropropane	0.006				0.005
Methylene Chloride			(.00019)	(.00019)	
*degradation product of chloroform					

As part of the process for developing a final drinking water standard, MCL goals are established at concentrations that are associated with no known or anticipated adverse health effects. MCLs are set at concentrations as close to MCLGs as is feasible.

Federal ambient water quality criteria are guidelines developed by the EPA Office of Water Regulations and Standards for the protection of aquatic life and human health. Although these are not enforceable standards, they represent scientific data and guidance to be used by the states in developing water quality standards. Federal ambient water quality criteria (adjusted for drinking water only) may be used in evaluating the significance of concentrations in groundwater at waste sites.

State environmental quality standards may be applicable or relevant and appropriate for evaluating remedial actions at waste sites in that state. The availability of, and numerical values for, these standards may vary widely from state to state, and may be more restrictive than Federal criteria and standards. The revised National Contingency Plan notes that state standards, requirements, criteria, or limitations are to be considered ARARs only if these have been formally promulgated and consistently applied. Idaho's current drinking water standards and waste quality standards are not more stringent than the Federal standards, therefore, the Federal standards are used in subsequent analyses.

The revised National Contingency Plan identified MCLs as the relevant and appropriate requirements for evaluating groundwater and surface water supplies that are currently, or potentially, used as a source of drinking water. When a promulgated maximum contaminant level exists, the Federal water quality criterion for that chemical would not be relevant and appropriate (55 FR 8813). When MCLs are not available, the National Contingency Plan specifies that the Federal water quality criteria may be relevant and appropriate in water that is a potential drinking water source. The National Contingency Plan states, however, that Federal water quality criteria without modification are not considered relevant and appropriate in selecting cleanup levels in groundwater, where consumption of contaminated fish is not a concern. Federal water quality criteria adjusted for drinking water only would be the alternate relevant and appropriate requirement for groundwater supplies.

### **3.4.2 Location-Specific ARARs**

A number of statutes have requirements related to activities occurring in particular locations. For instance, waste management activities in flood plains are restricted under RCRA and critical habitats of endangered or threatened species are protected under the Endangered Species Act. Location-specific ARARs are regulatory requirements or restrictions placed on activities in specific locations that must be met by a given remedial action. These location-specific ARARs are used in conjunction with chemical-specific and action-specific ARARs to ensure that remedial actions are protective of human health and the environment by meeting the requirements of all applicable or relevant and appropriate Federal and state regulations. The location-specific ARARs are also used to establish remedial action objectives.

This section identifies a preliminary set of location-specific ARARs that may apply to remedial actions at the SDA. Section 3.4.2.1 identifies general location-specific regulatory requirements and Section 3.4.2.2 presents an analysis of the applicability of these requirements to the SDA.

**3.4.2.1 Identification of Location-Specific Regulatory Requirements.** Federal and Idaho statutes and regulations were reviewed to identify potentially applicable location-specific regulatory

requirements that may apply to remedial activities and new hazardous waste activities (as a result of remediation) at the SDA. All of the requirements identified in this subsection have a location-specific orientation and restrict or prohibit certain activities at or near a location such as that occupied by the SDA. Specific characteristics of the SDA considered in this evaluation are its location in a flood plain, its location in a seismic region, the presence of endangered species, the proximity of surface water, the presence of archaeological and historical sites the area, and the presence of drinking water wells.

The following regulatory requirements, with potential applicability to remedial activities at the SDA, were identified:

- Flood plains [40 CFR 270 and 264; 40 CFR 6, Appendix A (Executive Order 11988)]; Fish and Wildlife Coordination Act (16 USC 661 et seq., 40 CFR 6.302, and Idaho Hazardous Waste Management Regulations, Title 1, Ch. 5, 01.5227,09)
- Seismic consideration (40 CFR 270 and 264; Idaho Hazardous Waste Management Regulations, Title 1, Ch. 5, 01.5227,09)
- Activities in the proximity of drinking water wells (Idaho Drinking Water Regulation, IDAPA 16.01.8900,07)
- Wetlands [10 CFR 1022, 40 CFR 230; 33 CFR Parts 320-330; and 40 CFR 6, Appendix A (Executive Order 11988)]
- Endangered species (50 CFR Parts 17, 200, and 402; 33 CFR Parts 320-330)
- Archaeological Resources and Antiquities (Archaeological Resources Protection Act; 43 CFR 7, 36 CFR Parts 65 and 296; and 25 CFR 261)
- National Historic Places (National Historic Preservation Act, 16 USC 470; 36 CFR 800)
- Fish and Wildlife (40 CFR 6).

**3.4.2.2 Determination of Preliminary Location-Specific ARARs for the SDA.** A review of the eight location-specific regulatory requirements presented in the previous section suggests that three of these requirements may be appropriate as ARARs for the SDA (flood plains, activities in the proximity of drinking water wells, and archaeological resources and antiquities) and five are neither applicable nor relevant and appropriate to the SDA (wetlands, endangered species, fish and wildlife, seismic, and national historic places). A discussion of these various regulatory requirements and their applicability or relevance and appropriateness to the SDA is provided below.

**3.4.2.2.1 Preliminary Location-Specific ARARs**—The identified location-specific ARARs include flood plains, activities in the proximity of drinking water wells, and archaeological resources and antiquities. The requirements of these location-specific ARARs are presented in Table 3-24.

**Table 3-24.** Summary of preliminary location specific ARARs.

Location-specific ARAR	Regulatory citation	Location requirements	Applicability to SDA
Flood plains	40 CFR Part 270 40 CFR Part 264 40 CFR Part 6 Idaho H.W. Mgmt. Regs. (01.5227,09)	If within 100-year flood plain, a new facility must be able to withstand washout from a 100-year flood  Facilities must demonstrate capability to either (a) withstand washout, (b) remove wastes prior to flooding, or (c) demonstrate that no adverse impacts will result from a washout	SDA located in 100-year flood plain
Activities in the proximity of drinking water wells	Idaho Drinking Water Reg., IDAP 16.01.89000,07	Specifies minimum distances between drinking water wells and various sanitary waste management units or other structures	The RWMC has an onsite drinking water well; relocation of the RWMC water supply well is a potential action  Sewer lines, septic tanks and fields, ditches, etc., must be a specified minimum distance from the drinking water well
Archaeological resources and antiquities	43 CFR 7 36 CFR 65 36 CFR 296 25 CFR 261	Established conditions for permits authorizing the excavation and/or removal of archaeological resources and antiquities from public and Indian lands  Establishes conditions to prevent disturbances of archaeological resources and antiquities on public and Indian lands	Several archaeological sites exist in the vicinity of the SDA

The SDA is located in the flood plain of the Big Lost River, an intermittent stream that passes approximately 2 mi to the north of the site. The SDA is actually situated in a basin that is 30 to 40 ft below the elevation of the river. Flow in the river is variable with snowmelt and rains contributing to high flows in late spring/early summer. In order to protect the SDA as well as other INEL areas, an extensive flood control system has been built at the INEL that uses a diversion gate and a series of spreading areas. The spreading areas are located approximately 1 mi to the west of the SDA. Dikes have also been constructed near and around the SDA to prevent flooding of the site from runoff. Regulatory requirements that apply to activities in flood plains include RCRA and State of Idaho requirements that restrict hazardous waste management activities in such areas.

A number of archaeological surveys have been conducted at the INEL in the past, and the location and surveying of sites and the preservation of antiquities continue. Several sites are located in the vicinity of the SDA. However, no material of archaeological or historical value has been found at the SDA, which has been extensively disturbed for over 20 years. Remedial activities within the SDA are not anticipated to encounter such materials either. Therefore, the regulatory requirements associated with the preservation of antiquities and archaeological materials/sites will only serve as ARARs for any activities conducted in the vicinity of the SDA but not within it.

The State of Idaho drinking water regulations include specified minimum distances from drinking water wells that certain waste management units and associated activities must maintain. Such facilities include sewer lines, canals, and ditches. If a new production well were to be installed at the SDA, specified distances would have to be maintained. Also, if in the course of remediation, new ditches or other such structures were to be constructed, the specified distances would have to be maintained against the existing production well.

**3.4.2.2.2 Location-Specific Regulatory Requirements Inappropriate to the SDA**—A number of the previously-identified, location-specific regulatory requirements do not qualify as being either applicable or relevant and appropriate to the SDA, and include

- Wetlands
- Endangered species
- Fish and wildlife
- Seismic events
- Historic places.

The flood control diversion ponds that are located 1 mi to the west of the SDA provide wetlands during wet seasons of the year. When these areas contain water, they are visited by a number of animal and bird species, particularly waterfowl. The SDA is isolated from the diversion ponds by a series of dikes and other engineered structures. Anticipated activities at the SDA are not expected to have any impact on the diversion ponds.

The SDA is not known to be located within a critical habitat of an endangered or threatened species nor are such species known to frequent the SDA. However, bald eagles and American peregrine falcons have been observed at the INEL. In addition, eight species of concern to the Idaho Department of Fish and Game and the Bureau of Land Management have been observed at the INEL. Remedial activities at the SDA are not expected to affect any endangered species because activities are anticipated to be restricted to the immediate area of the SDA itself.

No fish or wildlife addressed by the Fish and Wildlife Coordination Act are found at the SDA. Neither do the planned activities at the SDA involve the modification of a stream as no streams are located on the site and surface runoff is controlled. Regulatory requirements associated with the protection of fish and wildlife would not be applicable unless significant amounts of water are discharged along the RWMC drainage channel to the Big Lost River as part of remedial action activities. No discharge is planned during the remedial action.

The seismic standards contained in the RCRA and Idaho regulations are only applicable in certain counties, as specified in the regulations themselves. The SDA is located in Butte County, which is listed neither in Appendix VI to 40 CFR Part 264 nor the Idaho regulations and is, therefore, exempt from demonstrating compliance with the seismic standard.

There are no historic sites at the SDA. The Experimental Breeder Reactor No. 1, located approximately 2 mi to the northeast of the SDA, is a National Historic Landmark and the only historic site at the INEL.

### **3.4.3 Action-Specific ARARs**

Action-specific ARARs are performance, design, or other action-specific requirements that apply as a result of a specific technology or activity, or that are limitations on certain actions involving hazardous or mixed waste. Action-specific ARARs are identified during the development of remedial alternatives in the FS, which is outside the current scope of this report. Specific requirements are triggered by the particular remedial activities within each alternative. This section presents a preliminary list of laws and regulations to be considered in a later effort to develop action-specific ARARs.

The buried wastes at the SDA include chemicals and other wastes that would be considered hazardous wastes or radioactive mixed wastes under today's regulatory definitions. Migration of chemical constituents from the waste constitutes migration of the waste; therefore, any treatment actions applied to the waste or to soil, air, or groundwater contaminated by migrated contaminants may constitute management of hazardous or mixed wastes, or may generate wastes (e.g., treatment residuals) to be managed as hazardous or mixed wastes. Applicable regulations would include RCRA regulations (40 CFR 260-264, 268, and 270) and the Idaho hazardous waste management regulations (Title 1, Ch. 5). Other guidances to be considered include DOE Orders 5480.1A, 5480.1B, and 5820.2.

Treatment activities resulting in discharges to air, surface water, or the groundwater will need to comply with the following:

- Rules and regulations for the control of air pollution in Idaho
- Federal Clean Air Act

- Idaho water quality standards and wastewater treatment requirements (Title 1, Ch. 2)
- Licensing requirements for land disposal of radioactive waste (10 CFR 61)
- Federal Clean Water Act
- Federal and State of Idaho underground injection control regulations.

Treatment of drinking water or replacement of the existing potable water system would have to comply with Idaho drinking water regulations and the Federal Safe Drinking Water Act.

Other requirements can be identified based on specific remedial action alternatives or technologies being considered for the SDA. This would include all pertinent DOE-ID and EG&G Idaho requirements for design standards (such as seismic and tornado), operating requirements, and discharge/exposure limitations as well as compliance with the National Environmental Policy Act (NEPA).

### **3.5 Preliminary Assessment of Potential Impacts to Public Health and the Environment**

#### **3.5.1 Objectives**

The objectives of this section are to

- Identify site VOCs that will be evaluated in the baseline risk assessment
- Identify gaps in the existing data base.

#### **3.5.2 Target Volatile Organic Contaminants**

Investigations have been conducted to estimate the concentration levels of known and suspected VOCs located in the SDA vadose zone as discussed in Section 3.3. Much of the data from these investigations has been summarized (SAIC 1989), and the maximum concentration of VOCs reported in environmental media are presented in Table 3-18. This table gives an indication of the types of contaminants detected and the maximum concentrations observed. Information on radionuclide and inorganic contaminant concentrations is included in Table 3-18; however, this information will be addressed in another operable unit. Contaminants of concern, thus far, have been identified from historical records and past studies.

The nature and extent of soil and groundwater contamination have not been sufficiently determined to permit computation of accurate contaminant concentrations, identification of contaminant boundaries, selection of indicator chemicals, and development of quantitative estimates of the potential health risks to site workers and the general public.



### 3.5.3 Conclusions

Two conclusions may be drawn from the current data base and preliminary exposure indices:

1. An insufficient data base currently exists to comprehensively characterize site contamination and to permit quantitative evaluation of the risk potentially incurred by site workers, the general public, and the environment. Therefore, an extensive evaluation of existing data and a comprehensive Remedial Investigation program is required to compile the data sufficient to characterize site contamination conditions.
2. Exceptionally high preliminary exposure indices were computed using reported maximum contaminant concentrations and the preliminary remedial action levels proposed by SAIC (1989). While these exposure indices may overestimate actual overall exposure conditions at the SDA, they do indicate that potentially hazardous contamination areas exist, and that additional data are required to identify these areas. Once the necessary data are obtained, a quantitative baseline risk assessment may be conducted following the procedures outlined in Section 5.2.

## 3.6 Preliminary Remedial Action Objectives and Alternatives

Preliminary general response objectives and media-specific remedial action objectives have been established for the SDA. In the absence of known contamination levels or established action levels for most media, remedial action objectives containing general action levels were developed. Section 3.6.1 provides a discussion of the preliminary objectives.

A preliminary list of remedial alternatives has been developed for each medium based on the preliminary remedial action objectives. A discussion of the preliminary list of alternatives is presented in Section 3.6.2.

### 3.6.1 Preliminary Remedial Action Objectives

General response objectives derived from RI/FS objectives (Section 4.1), have been established that provide a framework for future analyses. The major concerns regarding contaminants at this time are risks to RWMC workers, the continuing need for a water supply at the RWMC, and continued migration of volatile organics from buried waste (SAIC 1989). The following list includes the preliminary general response objectives that have been identified to address these concerns. The general response objectives that have been developed are consistent with the goals set forth by DOE for environmental restoration projects at DOE sites (DOE Order 5400.1). The objectives include

- Protect human health and the environment
- Mitigate contaminant migration beyond the INEL boundary
- Minimize contaminant migration originating at the SDA
- Comply with applicable local, State of Idaho, and Federal (DOE, EPA, and Nuclear Regulatory Commission) regulations

- Minimize further migration of VOC contamination in the vadose zone to other environmental media (groundwater, surface water, air, etc.)
- Minimize SDA and INEL Site worker exposure to chemical waste constituents and hazards.

The EPA has identified nine criteria to be applied in evaluating and selecting remedial action alternatives. Of these, overall protection of human health and the environment and compliance with ARARs or Federal and State environmental and public health laws are considered the two threshold criteria that must be satisfied for an alternative to be eligible for selection. These two threshold criteria are the basis for developing cleanup levels for site remediation. These cleanup levels or remedial action goals are chemical-specific levels established for each chemical in each exposure route of concern, and serve as the foundation for developing and evaluating remedial action alternatives and for estimating associated costs. The other seven criteria are long-term effectiveness, reduction of toxicity, mobility and volume through treatment, short-term effectiveness, implementability, cost, state acceptance, and community acceptance.

Using the general response objectives as a basis, preliminary media-specific remedial action objectives have been developed and are listed in Table 3-25. Because action levels have not been established, the objectives reference the risk assessment as the source of the chemical/ specific action levels. The media for which the objectives were developed include the waste source material, surface soils, basalts and interbeds (vadose zone), surface water, groundwater, and air. With the exception of the waste source material, contamination has been detected in only one of the media above expected ARARS. Analyses of current (Leenheer et al. 1984 and Mann et al. 1988) sampling data have found no indication of hazardous or radioactive materials above expected ARARs being present in any of the media except the groundwater. Carbon tetrachloride has been detected in one well sample (Well 88) at levels slightly above the drinking water standards. Subsequent sampling of the well has not resulted in detection of carbon tetrachloride in similar concentrations to the above sample (Leenheer et al. 1984).

If future monitoring of air, water, and soil detects hazardous constituents above established action levels, remedial action objectives for human health and the environment will be developed that specify the contaminants of concern in each media, the exposure routes and receptors, and an acceptable contaminant level for each exposure route. An acceptable contaminant level is the cleanup criteria set by the IDHW and EPA.

The remedial action objectives related to environmental protection are usually intended to either preserve or restore a resource (such as groundwater). As a result, environmental protection objectives should be to reach cleanup levels, if possible.

### **3.6.2 Preliminary Remedial Alternatives**

The objective of this section is to identify preliminary remedial alternatives that could satisfy remediation objectives discussed in Section 3.6.1. The following five remedial alternatives are presently being considered:

**Table 3-25.** Preliminary media-specific remedial action objectives.

Environmental media	For human health	For environmental protection
Air	If it is determined that emissions above action levels established by the final ARARs or Risk Assessment are occurring, source control measures will be implemented to prevent inhalation, ingestion, or dermal contact.	Mitigate deterioration (beyond acceptable limits) of the air and biota.
Surface soils	If it is determined that contamination above action levels established in the final ARARs or Risk Assessment has occurred, the quantity, mobility, and/or toxicity of the organic contaminants will be reduced to prevent ingestion, dermal contact, or inhalation of contaminated material present at concentrations above allowable limits.	Mitigate migration of organic contaminants that would result in contamination of other media beyond acceptable limits.
Basalt and interbeds (vadose)	If it is determined that contamination above action levels established in the final ARARs or Risk Assessment has occurred, the quantity, mobility, and/or toxicity of the organic contaminants will be reduced to prevent ingestion, dermal contact, or inhalation of contaminated material present at concentrations above allowable limits.	Mitigate migration of organic contaminants that would result in contamination of other media beyond acceptable limits.
Groundwater (Snake River Plain Aquifer)	If it is determined that contamination above action levels established in the final ARARs or Risk Assessment is occurring, source control measures will be implemented to prevent contamination of the groundwater aquifer.	Mitigate the deterioration of water quality (beyond acceptable limits) in drinking water wells tapping the Snake River Plain Aquifer downgradient of the SDA.

1. *In Situ Treatment.* Includes methods for chemical, biological, or physical manipulations that degrade, remove, or immobilize contaminants in place. In situ chemical and physical treatments have not been successful in treating or immobilizing VOCs.<sup>h</sup> Although Vapor vacuum extraction (VVE) may be considered an in situ physical treatment, it is a candidate technology that will be further developed in a treatability study.
2. *Excavation, Treatment, and Disposal.* Includes removal of the contaminated subsurface (matrix and contaminant), treatment, and disposal. Treatment might include thermal or chemical processing to remove the hazardous components from the matrix material.
3. *Institutional Controls.* Includes fencing or other methods of limiting access.
4. *Containment.* Includes site capping, grout walls, or other geologic barriers.
5. *No Action.* No action will be taken to alter the site, although the area will continue to be monitored.

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h. Personnel communication with Gary Dintsch, Hazwrap, Martin Marietta Energy Systems, Inc. Oak Ridge, Tennessee.